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20 November 1959

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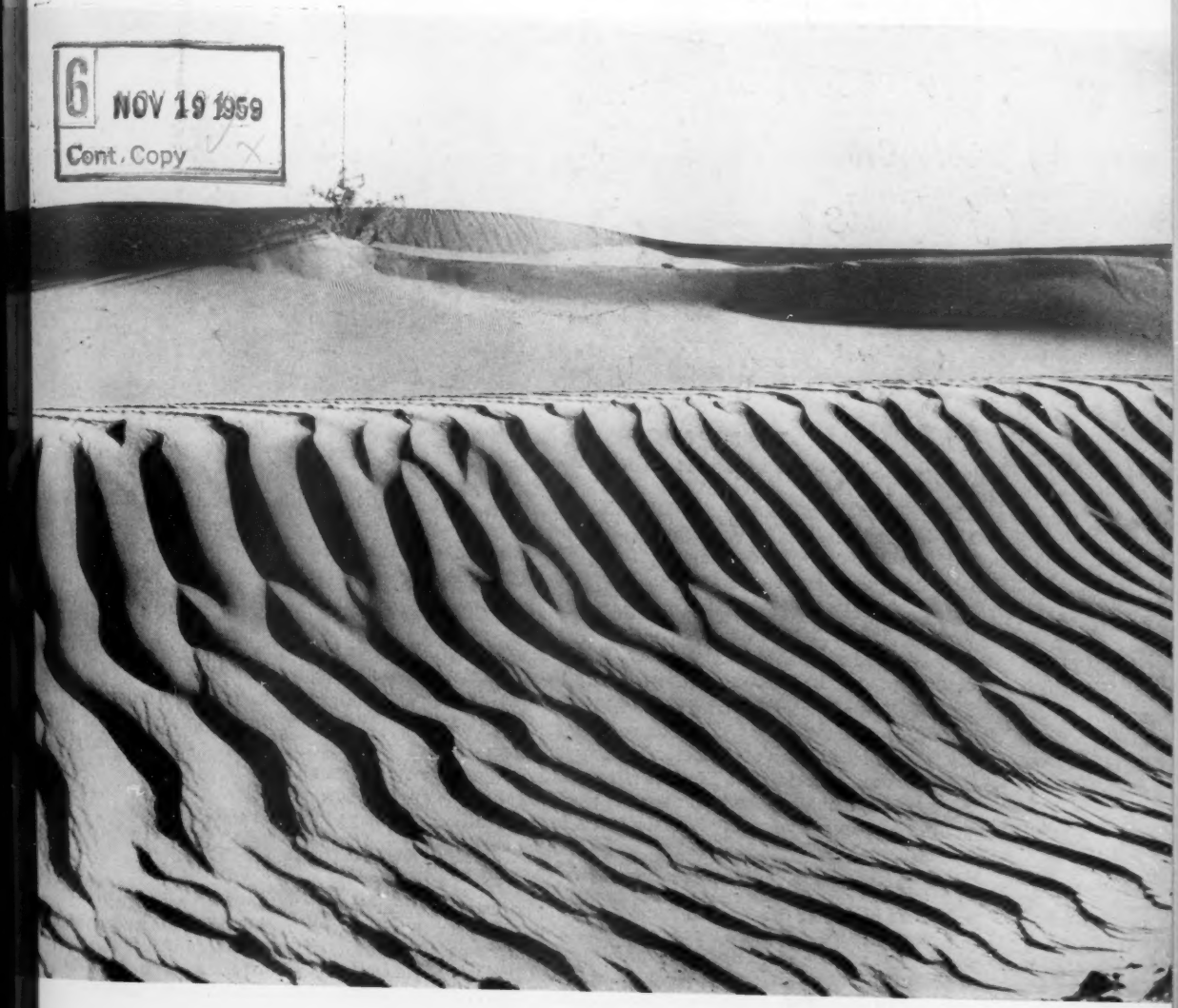

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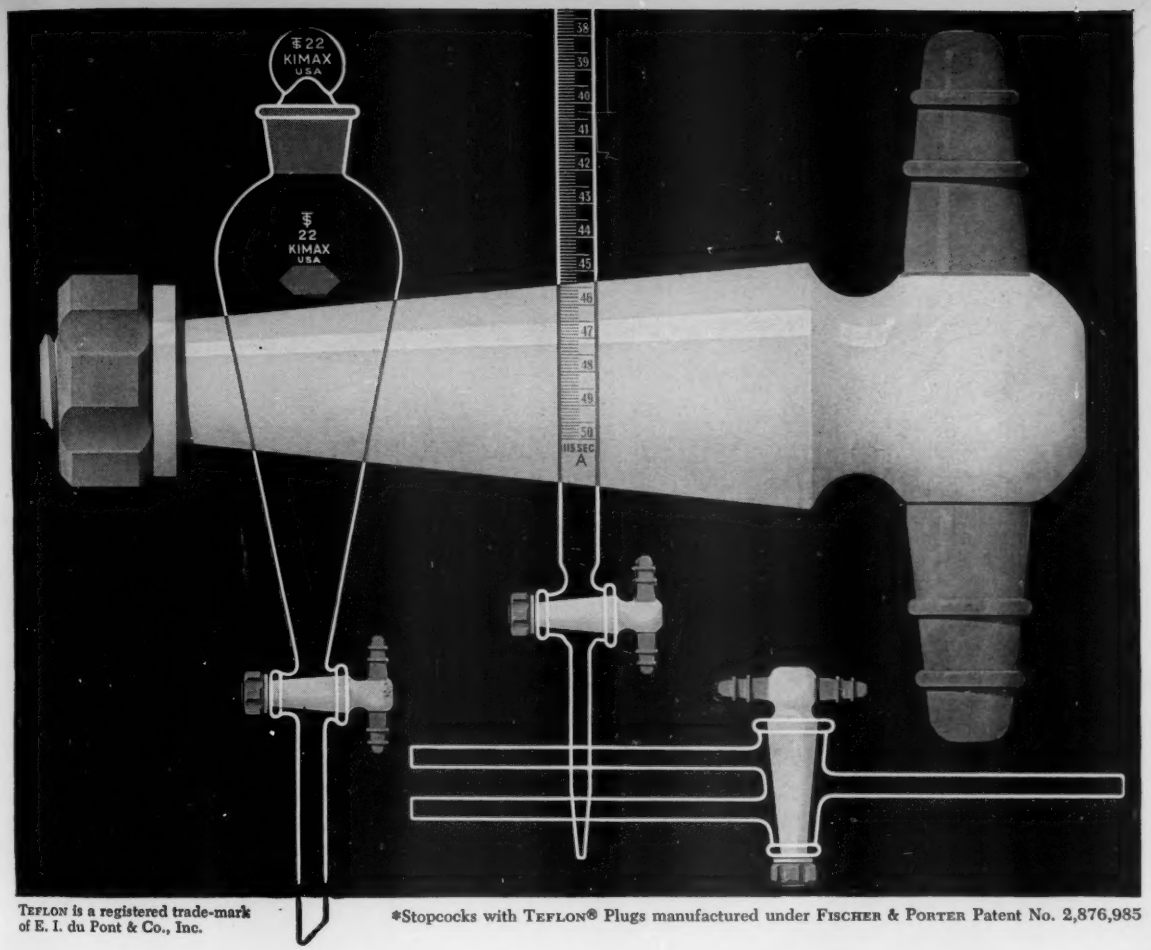

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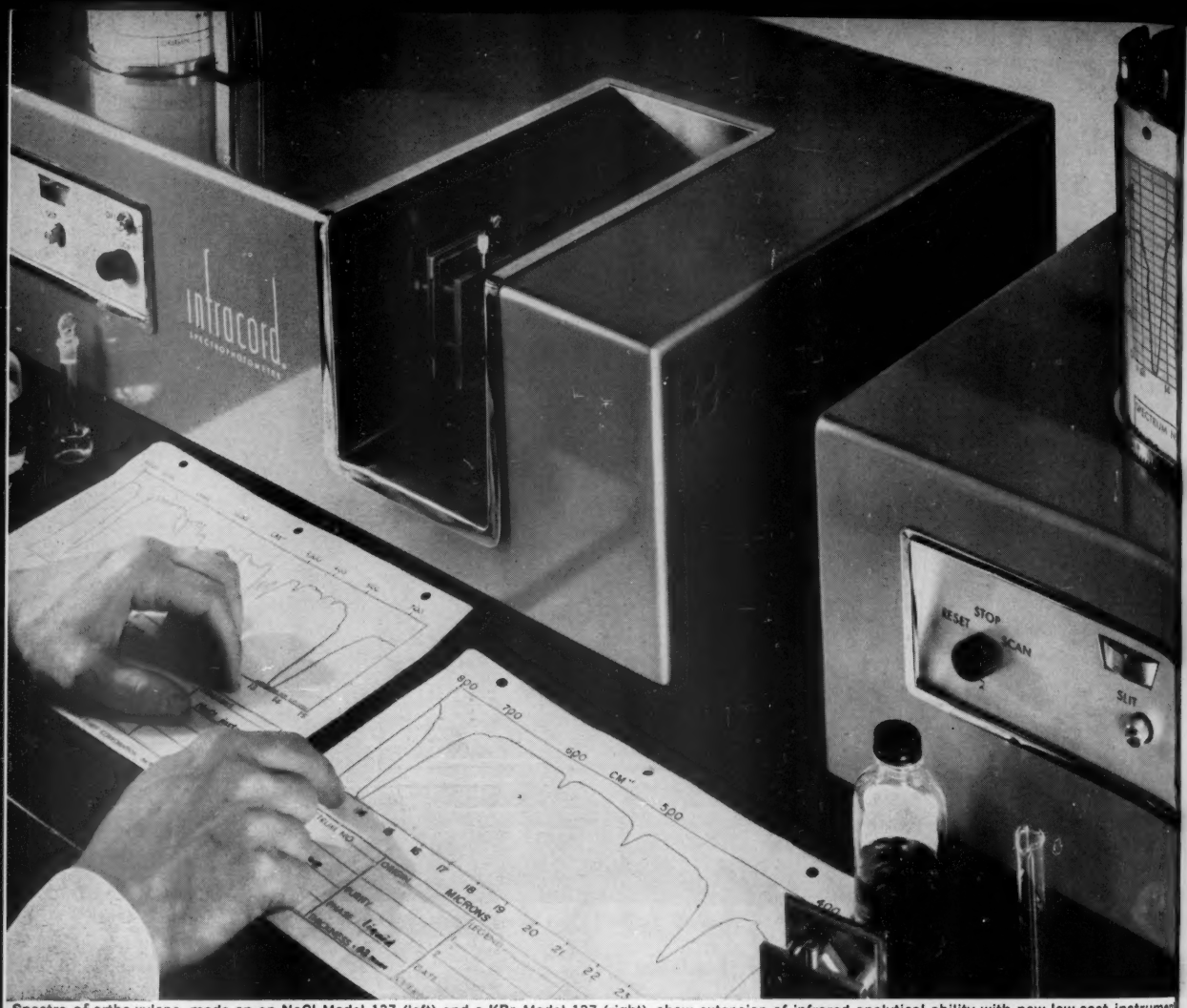

Spectra of ortho-xylene, made on an NaCl Model 137 (left) and a KBr Model 137 (right), show extension of infrared analytical ability with new low-cost instrument

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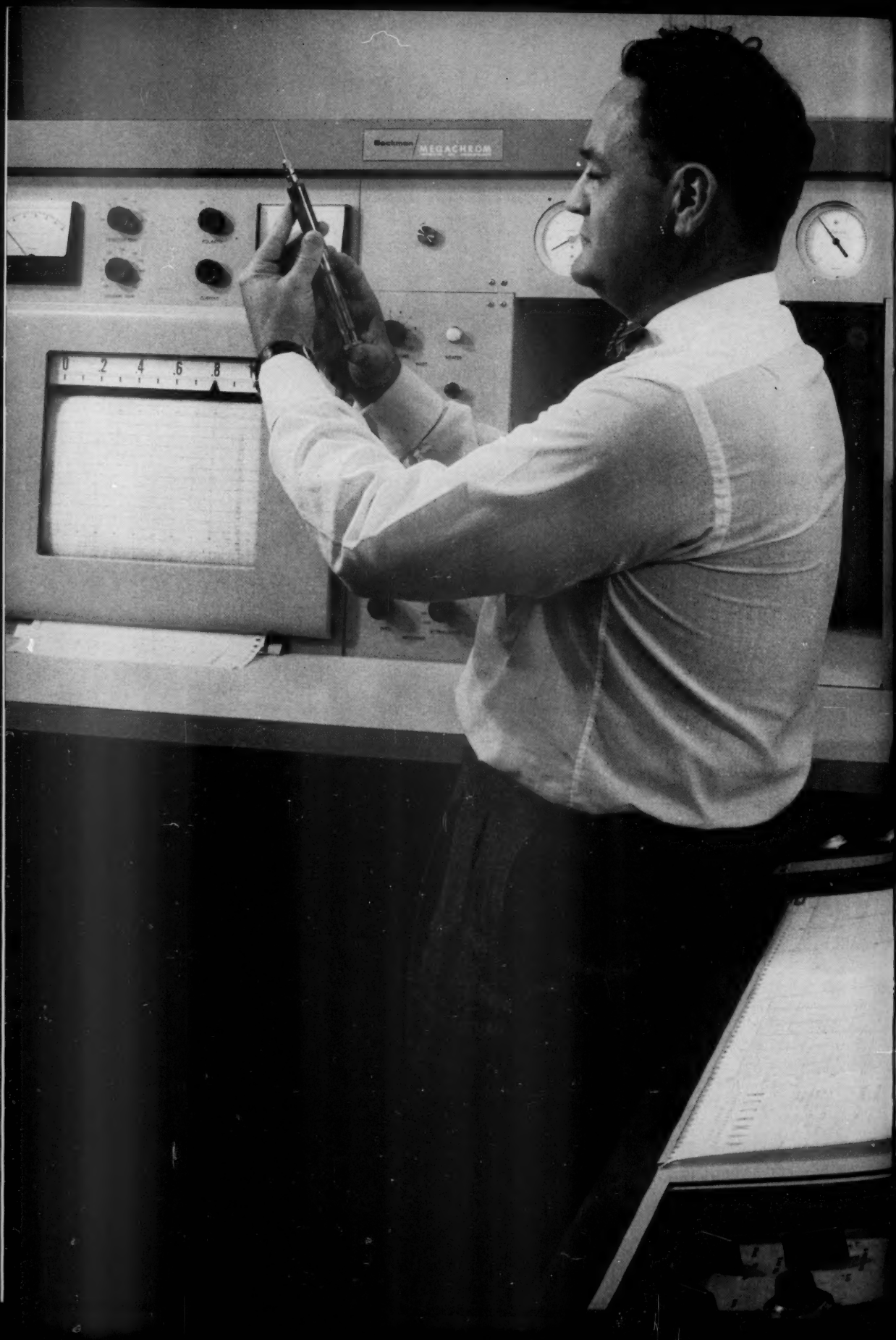
Cover These dunes, sculptured by the wind, are near Sebha, Libya (population 1702), a town in a Saharan oasis. The picture is from *Africa*, a book of photographs by Emil Schulthess, published by Simon and Schuster, New York. See review on page 1402.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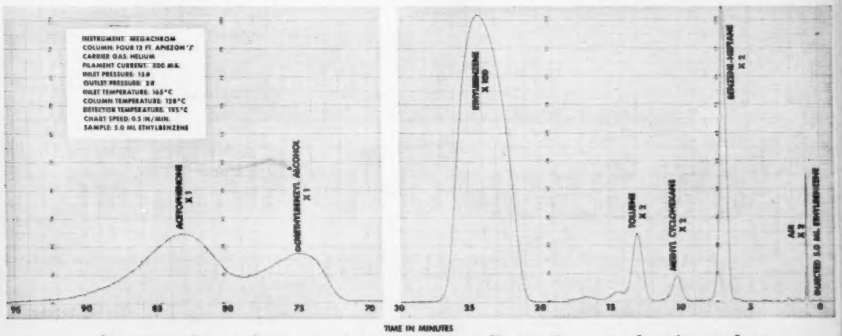
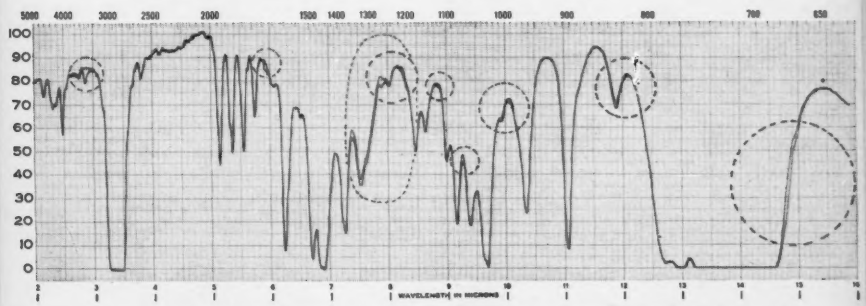
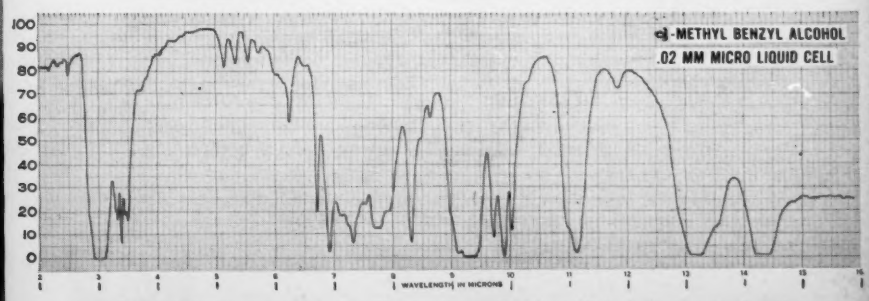


Chromatogram of 5.0 ml. of commercial 99% ethylbenzene fractionated on Megachrom. (Megachrom can handle as much as 20 ml.) Note resolution of contaminants which total only 1% of injected sample.



Infrared spectra of Megachrom-pure ethylbenzene (upper curve) and unpurified commercial ethylbenzene (lower curve). Impurity bands are circled.



Infrared spectrum of 0.1 microliters of α-methyl benzyl alcohol, a contaminant collected by Megachrom. With ordinary chromatograph, collection of this quantity of fraction for infrared or other analysis would be tedious or impossible.

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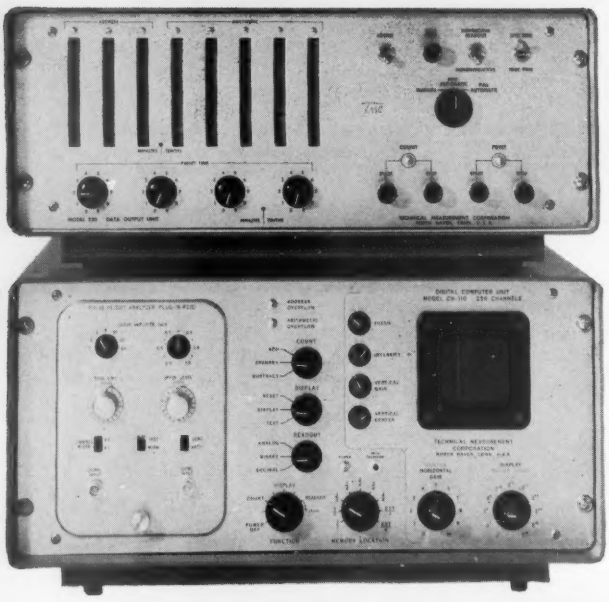

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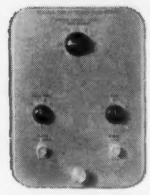

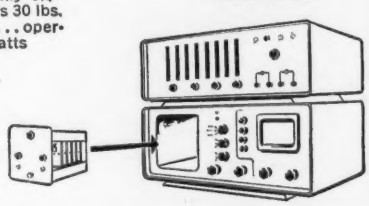

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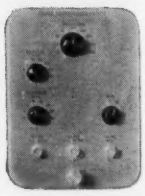

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One Hat That's in the Ring

Although most of the potential candidates for the 1960 Presidential nominations have not yet become actual candidates, one issue coming to the fore, as it did in the 1956 campaign, is that of a moratorium on nuclear testing. In the previous campaign, a proposal by Adlai E. Stevenson to suspend tests was dismissed by Dwight D. Eisenhower as a political gesture. Since then the administration has suspended tests and attempted to negotiate a permanent ban. A sticking point in the negotiations has been the Soviet Union's reluctance to agree to a sufficient number of on-site inspections of unidentified seismic events to make control effective. With the test suspension scheduled to end 31 December, the issue is whether wisdom lies in our continuing the suspension, and if so, for how long, or in testing weapons again.

A recent exchange of opinion in this country on test ban negotiations began 25 October, when in the course of a television question period, New York Governor Nelson A. Rockefeller stated that the United States should resume nuclear tests but restrict them to underground experiments in which radioactivity contamination of the atmosphere is negligible. The Republican Governor was promptly taken to task by a Democratic senator. In a speech delivered 2 November at the University of California at Los Angeles, Senator John F. Kennedy of Massachusetts urged that the suspension of nuclear tests be continued as long as the Soviet Union does not resume them and negotiations for a permanent ban make progress. If negotiations collapse, Kennedy said, the United States should resume testing but only underground or in outer space. The views of the Senator were opposed, in turn, by another Democrat but one who, we can be sure, is not seeking the Presidential nomination. In an article published 8 November in many newspapers, Harry S. Truman found little sense in our abstaining now from underground experiments. Disagreement with the position taken by Rockefeller and Truman was then voiced at a press conference 12 November in Wisconsin Rapids, Wis., by Vice President Richard M. Nixon.

The most detailed plan for action by the United States was offered in a talk delivered 30 October in Pontiac, Mich., by Senator Hubert H. Humphrey. The Democrat from Minnesota distinguished between the problems posed for mobile inspections by explosions with a yield of 5000 tons or more and the problems posed by smaller explosions. According to Humphrey's plan, the present moratorium on all testing should be extended for a period up to one year to allow further work on the problem of larger explosions. This problem is simpler than that of smaller explosions because effective control would require considerably fewer inspection trips. The number needed in the Soviet Union, the Senator said, would be between 25 and 50. If agreement on the first problem were reached, the plan continues, the moratorium on smaller explosions should be extended another two years; during this time the participating nations could study methods for improving the policing of smaller explosions without increasing unreasonably the number of mobile inspections.

This sample of opinion points up some aspects of the test ban issue. The two Republicans and three Democrats are agreed that if tests are resumed they should not take place in the atmosphere. Aside from the amount of detail that these thinkers are willing, or able, to specify, differences on how long to continue negotiations center not on scientific or technical matters but on different estimates of Soviet intentions. If a person believes that Moscow is seeking either a signed or *de facto* test ban but without controls, then he favors resuming our test program. Or, to reload the question, if a person believes that the evidence so far indicates that Moscow is negotiating in good faith, then he favors continuing the suspension.—J.T.

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Underdeveloped Economies

Both general and specific evidence refutes the thesis of the vicious circle of poverty and stagnation.

P. T. Bauer and B. S. Yamey

The underdeveloped countries and their economic problems have attracted increasing interest and attention during the last 15 years. A large flow of publications has appeared; and in view of the general and political interest in the subject, much of this literature is addressed, in part at least, to nonprofessional readers. At the same time, the work of economists has not yielded many illuminating insights or significant generalizations commensurate either with the effort in this sphere or with the volume of output. Yet there is one thesis or explanatory generalization which predominates the literature of the subject, both professional and popular. Most nonprofessional readers, if questioned in a free-association test, would call to mind this thesis of the vicious circle of poverty begetting poverty, with its important policy corollaries that underdeveloped countries can escape the constricting chains of poverty only by means of heroic efforts involving large-scale present sacrifices, with or without large-scale foreign aid. We need make no apology for devoting this article to an analysis of this thesis.

"Poverty Begets Poverty"

The reasoning underlying the thesis that poverty itself sets up well-nigh insurmountable obstacles to its own conquest can be cast in the form of a model, a device frequently and successfully used in other branches of economics. A model sets out the relationships between a limited number of economic variables selected for their supposed importance in the explanation of particular phenomena such as, say, the rate of economic growth. Although the precise formulation may vary from one source to another, the essential variables and relationships in most models of economic growth are as follows: the growth of income is a function of the rate of capital accumulation, that is, of investment; investment depends on saving; and saving is a function of income. Hence the growth of income depends on the growth of capital, and the growth of capital depends on the growth of income. These growth models are dynamic models purporting to show how one situation grows out of another, notably in this context explaining the factors behind changes through time in income and in the volume of production.

The model of the vicious circle of poverty or underdevelopment is a particular model to explain the continuation, through time, of a zero (or insignificant) rate of economic growth. Its mechanism pivots on a postulated low level of income per head which does not permit capital accumulation to take place and hence does not contain the motive power for an increase in the level of income. Here are two of the many formulations of this thesis.

The first formulation is that by the late Ragnar Nurkse. In his book *Problems of Capital Formation in Under-Developed Countries* he writes under the heading "The vicious circle of poverty":

"In discussions of the problem of economic development, a phrase that crops up frequently is 'the vicious circle of poverty.'. . . .

"A situation of this sort (a vicious circle of poverty), relating to a country as a whole, can be summed up in the trite proposition: 'a country is poor because it is poor.'

"Perhaps the most important circular relationships of this kind are those that afflict the accumulation of capital in economically backward countries. The supply of capital is governed by the ability and willingness to save; the demand for capital is governed by the incentives to invest. A circular relationship exists on both sides of the problem of capital formation in the poverty-ridden areas of the world.

"On the supply side, there is the small capacity to save, resulting from the low level of real income. The low real income is a reflection of low productivity, which in its turn is due largely to the lack of capital. The lack of capital is a result of the small capacity to save, and so the circle is complete.

"On the demand side, the inducement to invest may be low because of the small buying power of the people, which is due to their small real income, which again is due to low productivity. The low level of productivity, however, is a result of the small amount of capital used in production, which in its turn may be caused at least partly by the small inducement to invest.

"The low level of real income, reflecting low productivity, is a point that is common to both circles" (*1*).

For the second formulation we turn

Mr. Bauer is Smuts reader in Commonwealth studies, Cambridge University, and fellow of Gonville and Caius College, Cambridge. Mr. Yamey is reader in economics, London University.

to the study submitted by the Center for International Studies of the Massachusetts Institute of Technology for the Special Senate Committee on Foreign Aid:

". . . the general scarcity relative to population of nearly all resources creates a self-perpetuating vicious circle of poverty. Additional capital is necessary . . . to increase output, but poverty itself makes it impossible to carry out the required saving and investment by a voluntary reduction in consumption" (*2*).

The usefulness in economics of any particular model cannot be stated a priori. An infinite number of models can be devised for one situation. The relevant question is the illuminating nature of the model. This depends on its success in identifying the important variables and assessing their relationships. Ultimately the success and usefulness of the model depends on its value in explaining the past and also in predicting hitherto unobserved results.

We propose to test the model of the vicious circle of poverty in underdeveloped countries, to show that it is deficient, and to suggest why it is defective and misleading. In reaching the latter conclusion, however, we do not wish to be understood as implying that no country has ever been in a situation of which the model is a fairly exact image, or that there are no elements of truth in the component parts of the model. But we will attempt to show that the choice of variables and relationships between variables incorporated in the model rules out the possibility of explaining a great deal that has happened and is happening.

Evidence against the Model

It is indeed remarkable that the thesis of the vicious circle of underdevelopment should have been so widely espoused and accepted when it is amply refuted by the most obvious empirical evidence. It is refuted, first of all, by the very existence of developed countries. All of these started by being underdeveloped, that is, by having the economic features which define underdeveloped countries today: low average per capita incomes and low levels of accumulated capital; and yet they progressed, in most instances without appreciable external capital and invariably without grants from abroad. On the strict argument of the vicious circle of poverty, such development would have been impossible. The details of the process of growth in the now developed countries obviously vary greatly, and different interpretations of the process in a particular country are possible. But the evidence of growth is indisputable. This evidence is in itself sufficient to dispose of the thesis of the vicious circle of poverty as a firm generalization of wide applicability.

Moreover, the thesis is also refuted by the rapid economic advance apparent in many underdeveloped countries in recent decades. For example, the total gross national product of the Latin American countries covered by the annual reports of the Economic Commission for Latin America increased over the period 1935 through 1953 at an annual rate of over 4 percent, while output per head increased by over 2 percent. In more recent years the growth of output has been even faster, and the rates of growth in the aggregate and per head have exceeded the comparable figures in the United States.

Southeast Asia and West Africa are other regions which have developed very rapidly in the last 50 or 60 years. For these areas there are no series of national income figures going back before World War II. At present the national income of Malaya is around 300 U.S. dollars per head per annum, and that of Ghana (formerly the Gold Coast) around 200 U.S. dollars. These are low figures, but they nevertheless reflect substantial advances over the last half century or so, for at the turn of the century these were substantially subsistence economies. There is much other information on the rapid advance of these regions. The rubber industry of Southeast Asia began only around 1900, while today it produces close to 2 million tons of natural rubber, almost two-thirds of which is produced on Asian-owned properties. In the 1890's there were no exports of cocoa, groundnuts, or cotton from Nigeria and Ghana, and the exports of oil palm produce were about one-tenth of their present volume. Today, these are leading staples of world commerce, and total annual exports from these two countries are not far short of a billion dollars. In 1900 there were no (or only negligible) imports into these countries of flour, sugar, cigarettes, cement, petroleum products, or iron and steel. Today these commodities are imported on an impressive scale. It is of some interest that almost all West African agricultural exports are produced by Africans and practically all imports are destined for their use. Statistics of public revenue, infant mortality, literacy, railway transport, and the like, fill out the picture of rapid economic development.

Hong Kong provides another specific illustration of rapid growth, despite the presence within its boundaries of three of the features often said to reinforce the cumulative process of poverty perpetuating itself, namely, lack of natural resources, heavy pressure of population, and very restricted domestic markets.

Sources of Confusion

It is tempting to consider the reasons for the apparent rejection of the evidence of past and contemporary economic experience which is implicit in the espousal of the model of stagnation. But this is not the occasion to venture on the perilous seas of the sociology of knowledge. One point, however, may be made. The underdeveloped countries are clearly poor by the standards of North America and Western Europe; indeed, this constitutes the definition of underdevelopment. The tenor of the discussions centering around the vicious circle of poverty suggests a confusion between a low level of economic achievement and a zero (or low) rate of change in economic performance. It is clearly improper to identify a *level* with a *rate of change*. The unwarranted identification of a level and rate of change, or rather the confusion of the two, is especially remarkable at a time when mathematical techniques are being widely used by economists, including writers on underdeveloped countries who espouse the notion of the vicious circle of poverty and stagnation. Such a confusion is analogous to an identification of a child and a dwarf.

In many underdeveloped countries, with low levels of real income, some of the most burning and difficult problems of policy derive in fact from the rapidity of economic advance, particularly where, as is almost invariably and necessarily the case, growth does not manifest itself equally in all sectors or regions of an economy. Rapid and uneven change presents formidable problems to governments; but these problems are entirely different from those of

stagnation. Problems of changes in land tenure arrangements and in property rights and inheritance, problems of congestion and delay in ports and on the railroads, and problems of detribalization and the transformation of a subsistence into a money economy—these are pressing problems in a number of underdeveloped countries, and they would not arise in a stagnant economy caught within the coils of a vicious circle of poverty.

Reference should be made, in parentheses, to the measurement of economic progress. It is customary to use the yardstick of national income per head of population. This is perhaps convenient to indicate orders of magnitude. But too much must not be read into such indices of levels of economic achievement, or into derived statistics of rates of change. In many parts of the world economic progress has meant the suppression of slavery, tribal warfare, and the worst epidemic and endemic diseases; moreover, the whole flavor of life has been changed with the growth of cities and the development of communications, and with the replacement of local self-sufficiency by the possibilities of exchange. The qualitative nature of these changes cannot be reflected in statistics of national income, and the achievements of growth are likely to be understated. Moreover, emphasis on *per capita* income diverts attention from changes in the number of people sustained in an economy. Yet it is surely an achievement for an economy to sustain a larger population at a given average standard of living, just as it is an achievement to sustain the same number at a higher average standard of living. Increases in population throughout the underdeveloped world during the last half century largely reflect a fall in the death rate, itself more or less directly the consequence of economic advance. This is not reflected, however, in statistics of *per capita* national incomes; yet the position of those who have failed to die has certainly improved, as has the situation of those whose children continue to live. Concentration on per capita income figures implies a criterion of economic advance which registers the birth of a calf or the survival of a cow as a contribution to economic progress (since it constitutes capital formation), but the birth of a child or the survival of a person as a detraction from it, since the denominator in the index is enlarged.

Relationship between Capital and Growth

In the model of the vicious circle, capital formation appears as the engine of economic growth; and it is the low-income obstacle to capital formation which obstructs growth. No one would wish to dispute that there is a strong link between capital accumulation and economic growth or level of economic achievement, and that the level of capital is relatively low in underdeveloped countries (*3*). But the functional relationship between capital (as the independent variable) and economic growth (as the dependent variable) is seriously open to question; and it is this relationship which is implicit in the model. A few points will illustrate the shortcomings of this approach.

In the course of economic development many changes take place in the factors of production other than in the volume of capital. The aggregate size and the regional distribution of population change; wants, values, techniques, and attitudes are modified, including the attitude toward work and leisure; and skills are acquired. Some of these changes call for additional capital; others enable capital to be used productively; yet others require comparatively little additional capital, or may indeed economize in capital. And almost invariably there also occur major changes in the composition of both the stock of capital and of investment (*4*). Moreover, much of capital formation is not designed or destined to increase production, and hence future incomes, but represents expenditure of present income on durable goods. Examples include investment in houses, schools, public buildings, automobiles, and domestic equipment. This type of capital formation is a function of income, rather than the other way round. Capital formation and changes in the composition of capital are elements in the complicated web of economic change. It is misleading to single out capital formation as the key causal element or independent variable in the process. It is more illuminating to suggest that capital is created in the process of development rather than to suggest that development is a function of capital accumulation.

The assignment to capital of the key causal role in economic development has sometimes had unfortunate practical effects. The difficult problems connected with the *investment* of capital—for example, the selection of projects and undertakings—are apt to be ignored or treated lightly when it is believed that the *quantity* of capital accumulated and invested is what really matters. The aggregation of numerous acts of investment into a single aggregate, called capital formation, is expedient for the builder of models or the national planners; but it may lead to a misplaced emphasis on quantitative totals rather than on qualitative composition, which is conducive to waste of scarce resources. A specific example may illustrate these points. It is a familiar feature in many underdeveloped countries that it is easier for government departments to secure official approval to spend large sums on a specific investment project than it is for them to obtain approval for much smaller amounts for the investigation of possible investment projects or for maintenance expenditures to keep existing projects going.

Indeed, the habit of regarding development as dependent on investment has been responsible for much waste in the underdeveloped world. It has encouraged investment expenditure, especially by public bodies, practically regardless of cost in terms of alternative uses of resources, and regardless also of the repercussions of the taxation required for the collection of these funds. Yet expenditure does not become productive simply by being termed investment. This attitude of mind also tends to issue in a neglect of various government functions essential to economic development, but not requiring large-scale investment. The maintenance of law and order, the extension of knowledge, the efficient management of the supply of money, are among such functions.

Relationship between Saving and Income

The usual growth models, and notably that underlying the vicious circle of poverty, regard saving as an increasing function of income. While this is often a reasonable first approximation, the nature of the link is not so simple or general as is postulated in these models. Throughout the world innumerable originally poor individuals and groups have improved their economic position by foresight, thrift, and

the perception and exploitation of economic opportunity, which shows that low incomes do not set up an inexorable constraint on saving. An important set of examples of much significance in economic development is the rise to prosperity of communities of originally penniless immigrants. This is a familiar phenomenon, nowhere more in evidence, of course, than in North America. The contribution to capital formation of formerly indigent immigrant communities of Chinese, Indians and Lebanese in parts of Southeast Asia and Africa is more recent but just as striking. But there is no need to confine examples to immigrant communities. The establishment and extension of peasant small holdings on previously uncultivated land for the cultivation of crops for consumption by the cultivators or for sale, represents capital formation which both precedes and promotes a subsequent growth of income.

Thus, even in closed economies, that is, economies unaffected by economic intercourse with other economies, the model underlying the vicious circle of poverty fails to account for important factors and developments. And these defects are underlined and reinforced by the implications of international economic intercourse.

Beyond Conventional Economic Analysis

In a closed society operating at a low level of achievement, the model may indeed truly represent the basic facts of the situation in the absence of internal disturbing forces and of international contacts. If there is nothing to change the nature of the chosen relationships, then the results postulated by them will follow. But once the possibility, or indeed the likelihood, of internal disturbances or of external contacts is recognized, the low level stagnation no longer represents a stable equilibrium, and, as already noted, both the existence of developed countries and recent progress in many underdeveloped countries are ample evidence of the importance of such internal or external disturbances practically throughout the world. The emergence of opportunities originating from abroad in the form of new markets, new techniques, or new wants, is important among the influences upsetting stable relationships and leading to economic development. The emergence of these opportunities is essentially outside the range of the conventional tools of economic analysis, which makes it difficult to fit them into conventional economic models. But to deny their relevance and importance, as is implicit in the model of the vicious circle of poverty, is to assume away the problem. Also, it is historically inaccurate to suggest, as do some economists, that only a large-scale disturbance introduced by the state itself (usually by means of public investment financed from the proceeds of taxation or foreign aid) can successfully break the circle. Such a policy may succeed, though it need not necessarily succeed. Much more important, on both theoretical and practical grounds, is the fact that, as we have noted, other less spectacular methods have frequently, indeed generally, achieved the same purpose.

Economic development has often been stimulated and promoted by new and enlarged opportunities for the production or sale of goods and services, or for increased or more varied consumption. Such opportunities have often arisen through contacts with more advanced economies, which have stimulated new wants, brought new methods or crops to the notice of the population, or encouraged new sources of supply or opened up new markets for the disposal of output. Again, new opportunities for production, exchange, and consumption have emerged following the establishment of law and order, or the unification of a territory through the introduction of a common currency. Communities, groups, and individuals have differed widely in their responses to such new prospects and opportunities in effecting the required changes in modes of behavior and in institutional arrangements. These differences are obviously of great importance; yet the economist is not specially equipped to account for them.

But whenever there is some response, as is usually the case, these opportunities promote economic development by influencing the relationships between the variables isolated in the model of the vicious circle. For instance, the rate of saving does not depend simply on the level of income (as is generally implied in the usual formulation of the thesis of the vicious circle of poverty and stagnation), but is also much affected by investment opportunities. In the words of Albert O. Hirschman, "Additions to savings depend more on the opening up of investment opportunities and on the removal of various obstacles to investment activity than on increased income" (*5*). Because people invest to secure higher incomes, the relevance of investment opportunities is clear. Again, saving and investment can be promoted by the expectation of a higher and more varied level of consumption. People often save in order to invest to secure subsequently a higher income and improved standard of consumption. The prospects of a higher and more varied level of consumption depend partly on the range of available goods and services. The knowledge of new and attractive consumer goods often stimulates a higher rate of saving and investment out of a given income, and also often induces additional effort; in other words, it stimulates higher economic performance. In short, when new opportunities are available, and are pursued, it is inappropriate to work with a model which implies a static relationship between income, saving, and consumption.

Economic Analysis and Policy Prescription

The observed growth in many underdeveloped countries, without drastic internal measures or massive foreign aid, destroys the validity of propositions which often serve as bases for policy proposals; but it does not in itself resolve problems of economic policy in this sphere. In any event, prescriptions for policy, especially when these are so far-reaching as to affect the fabric of society, cannot be drawn directly from economic analysis. In the economics of underdeveloped countries, even more than in other branches of the subject, analysis and prescription have been confused, and this confusion has seriously impeded the development of analysis. The desire to offer prescriptions for policy seems to have caused many economists in this field to skimp on the work of observation and the testing of hypotheses, an attitude which has been reinforced by the tendency in economics to consider careful observation of phenomena and the testing of hypotheses (where it is possible) as trivial activity. These defects in approach largely explain the persistence of the manifestly untenable hypothesis of the vicious circle of poverty and stagnation. It is not necessary to dwell on the misleading nature of this kind

of approach in a journal addressed primarily to natural scientists. Students of applied economics have much to learn from the careful, painstaking, and patient researches of the natural scientists. We may fittingly conclude with some observations by Herbert Dingle, one of the most perceptive British historians of science, whose exhortations economists, especially those working in the sphere of underdeveloped countries, will do well to remember:

"We need to cultivate the restraint of Galileo, who left the world of angels and spirits until the time should come when it could be explored, and contented himself with such principles as he could extract with confidence from experience, though the resolution committed him to such trivialities as the timing of balls rolling down grooves. It is that self-control—the voluntary restriction to the task of extending knowledge outwards from the observed to the unobserved instead of imposing imagined universal principles inwards on the world of observation—that is the essential hallmark of the man of science, distinguishing him most fundamentally from the non-scientific philosopher" (*6*).

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2. "A study prepared at the request of the Special Committee to Study the Foreign Aid Program, United States Senate, by the Center for International Studies, Massachusetts Institute of Technology" (Washington, D.C., 1957), p. 37.
3. The level of capital formation in underdeveloped countries is often understated, because of the exclusion from the statistics of agricultural capital formation by small farmers. This exclusion reflects either the practical difficulty of measuring capital formation in this type of activity or the tendency to equate capital formation with investment in large-scale or otherwise easily identifiable undertakings. (This latter tendency, in turn, may reflect the common but often mistaken view that peasant farmers are too poor, too hidebound by tradition, and too limited in foresight to save and invest productively.) The seriousness of this omission is clear from the development of peasant agricultural production for sale (both for local consumption and for export) in many underdeveloped countries; and this implies the development of large areas of peasant holdings under cash crops—that is, substantial direct investment in agriculture.
4. The importance of changes in the composition of capital may be illustrated by reference to the Industrial Revolution in England. T. S. Ashton, a distinguished British economic historian, writes of 18th-century England that ". . . the speeding up of production and distribution by the new machines and new means of transport made it possible to transmute circulating into fixed capital. The process is at the centre of what is called the industrial revolution." [*An Economic History of England: The Eighteenth Century* (Methuen, London, 1955), p. 112.]
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Reoviruses

A new group of respiratory and enteric viruses formerly classified as ECHO type 10 is described.

Albert B. Sabin

The prototype (originally designated HE type 4 virus) of ECHO type 10 virus ("Lang" strain) (*1*) and four other closely related strains were first isolated and identified in this laboratory in 1954, from the stools of healthy children in Cincinnati (*2*) and Mexico (*3*). Subsequently, antigenically related strains were recovered from a spontaneous outbreak of rhinitis in chimpanzees (*4*), from a family outbreak of steatorrheic enteritis (*4*), from children with diarrhea (*5*), and from several outbreaks of illness in a nursery in Washington, D.C. (*6*). The sera of most human adults as well as of some monkeys, rabbits, and guinea pigs contain neutralizing antibodies, and antigenically related viruses have been recovered from monkeys (*7*, *8*) and recently also from naturally infected calves (*9*).

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Differentiation from Other Viruses

The inclusion of this virus in the ECHO group was originally based on its origin from human stools, its optimal isolation in monkey-kidney tissue cultures, and the lack of pathogenicity of the initial strains for newborn mice, guinea pigs, rabbits, and monkeys. It was soon found (*10*), however, that the viruses of the ECHO 10 group were much larger (about 75 mμ) than the other ECHO viruses, the Coxsackie viruses, and the polioviruses in the group of enteroviruses that had been measured by filtration through gradocol membranes (about 18 mμ or smaller).

The cytopathogenic effect in monkey-kidney tissue cultures produced by strains of the ECHO 10 group was distinctive and different from that produced by all other enteroviruses. Furthermore, ECHO 10 virus was found to have a cytopathogenic effect in primary cultures from the kidneys of guinea pigs, cats, and dogs, and to a lesser extent from those of rabbits and calves, in which the other enteroviruses were without effect (*11*). Subsequent work also indicated that the prototype ECHO 10 virus was capable of yielding a variant that was pathogenic for newborn mice, with production of lesions in the brain, myocardium, and liver (*10*, *12*), and that large doses of tissue-culture virus of some other strains exhibited a similar pathogenic effect on primary inoculation in newborn mice (*13*). It was also reported that low concentrations of periodate which were without effect on the receptors of human group O erythrocytes for the hemagglutinins of other ECHO viruses, as well as for those of influenza virus, completely destroyed the receptors for the ECHO 10 virus hemagglutinin (*14*).

Of all the properties which distinguished the ECHO 10 group of viruses from the other members in the group of enteroviruses, its large size seemed most important. Since the size of many of the Coxsackie and ECHO viruses was not known, and since size was not

one of the original criteria for inclusion of a virus in this group, there was no firm basis for separating the ECHO 10 strains from this group until it could be shown that however else the various naturally occurring and tissue-culture-propagated members of the group of enteroviruses might vary, they had in common a certain small range of size. Gradocol-membrane filtration tests recently completed in this laboratory (*15*) showed that all other established types of Coxsackie A, Coxsackie B, and ECHO viruses have a size in the range of 18 mμ or less. On the other hand, further tests on five strains representing different antigenic variants of the ECHO 10 group all yielded similar results, with a size of about 72 mμ (membranes with an APD of 130 mμ permitted the virus to pass, while those with an APD of 120 or 110 mμ held it back completely). This marked difference in size between all the other enteroviruses and the various strains of ECHO type 10 provides a sufficient basis for removing ECHO type 10 from the group of enteroviruses.

Properties

Detailed studies carried out in association with H. J. Eggers and M. A. Koch in this laboratory on various properties of 11 different strains have provided the definitive information required for establishing these strains as members of a new group of viruses, for which I am proposing the name "reoviruses."

This name is intended to stress the association of this group of viruses with both the respiratory and the enteric tracts. Although other viruses (for example, the adenoviruses and some types of ECHO) are similarly associated with both the respiratory and enteric tracts, it is difficult to select any other property of this new group that by itself is not also shared with other viruses. The "reoviruses" are characterized by the following properties.

1) They are ether-resistant.

2) They are approximately 72 mμ in size, as determined by filtration through gradocol membranes.

3) They have a distinctive cytopathogenic effect in monkey-kidney tissue culture, in which the cells separate from the sheet, assuming a granular, degenerated appearance with intact nuclei; in stained, cover-slip preparations, cytoplasmic inclusions of varying size and shape, first reported by Malherbe and Harwin (*7*), were also found in this laboratory with five different strains representing the three distinct antigenic serotypes; the cytoplasmic inclusions (Fig. 1) are red after staining with hematoxylin and eosin and blue with Giemsa (*16*); according to Drouhet (*17*) the inclusions are Feulgen negative, they fail to stain red by the Unna-Papenheim method after treatment with ribonuclease, and they are negative for mucopolysaccharide.

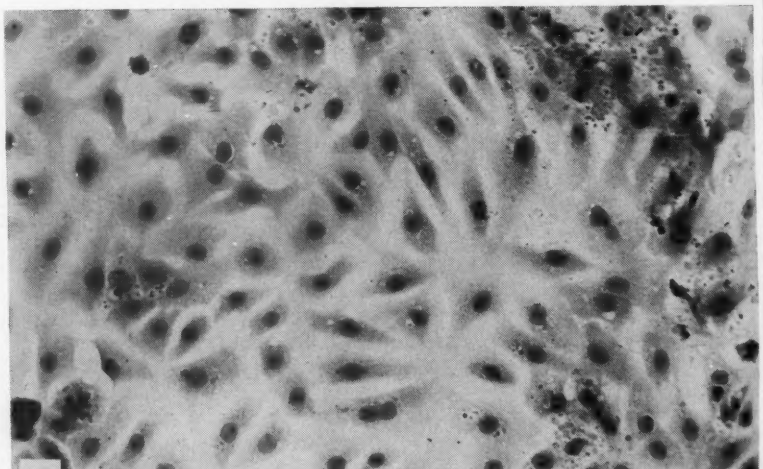
4) The prototype "Lang" strain propagated in monkey-kidney cells also produces a cytopathogenic effect in kidney-tissue cultures from guinea pigs, swine, cats, dogs, and partly also in those from calves and rabbits (*11*).

5) All tested strains multiply in newborn mice, and some produce clinical signs of disease, with lesions in nerve cells (cytoplasmic inclusions in some cells), myocardium, and liver, but lesions are rare in the pancreas, brown fat, and voluntary, striated muscle (*13*); adult mice remain well, but the extent, if any, of virus multiplication in them has not been determined.

6) The prototype ("Lang") strain has been reported to multiply in chick embryos (*18*).

7) Occasional monkeys die after intracerebral inoculation, with lesions in the ependymal lining of the ventricles and in the choroid plexus.

8) The "chimpanzee rhinitis" strain produces a distinctive "common cold" syndrome on nasal instillation in sus-



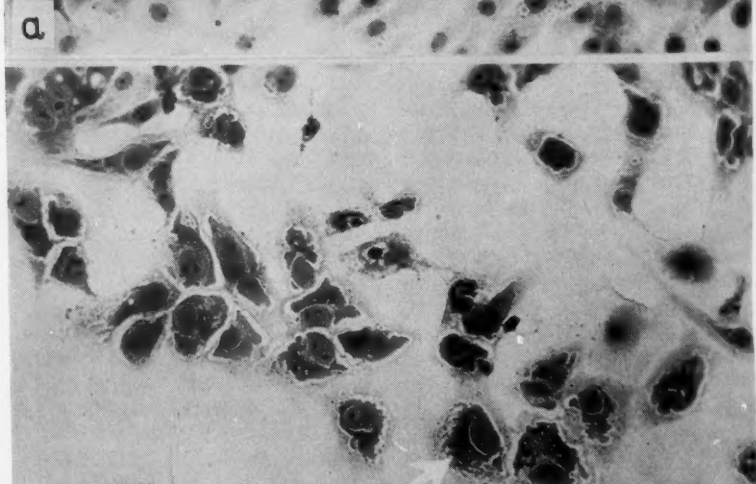


Fig. 1. (*a*) Uninoculated cynomolgus monkey kidney tissue culture; (*b*) cytoplasmic inclusions (arrow) in cells infected with reovirus.

ceptible chimpanzees, with virus multiplication both in the nasal passages and in the enteric tract (*19*).

9) All strains yield a hemagglutinin for human group O erythrocytes (*14, 20, 21*) but not for chicken, guinea-pig, sheep, or bovine erythrocytes (*14*); the erythrocyte receptors for this hemagglutinin are not affected by the receptor-destroying enzyme of *Vibrio cholerae* (RDE) (*20, 21*) but are destroyed by potassium periodate in concentrations as low as 1:1000 to 1:6000 (*14, 21*).

10) All strains possess a common complement-fixing antigen (*21*) but distinct antigenic differences are demonstrable by neutralization (*4, 5, 13*) and hemagglutination-inhibition tests (*21, 22*).

Distinct Antigenic Types

For the demonstration of antigenic differences by neutralization or hemagglutination-inhibition, antisera prepared in rabbits, especially in those without preexisting spontaneous antibody (*5, 13, 21*), or in guinea pigs and roosters (*22*), were found to be superior to those prepared by hyperimmunization of monkeys. By means of such tests (*13, 21, 22*), the available strains were clearly divisible into three distinct, but related, serotypes (Table 1).

For type 1, the prototype is the original ECHO 10, "Lang," strain; three other strains recovered from healthy children in Cincinnati ("Cocrel") and Mexico (CHHE 127 and 276), a simian virus (SV-12) (*8, 22*), and 22 strains isolated by Rosen *et al.* (*6*) during a 1957 winter outbreak in a Washington, D.C., nursery were also identified as type 1.

For type 2, the D 5 (Jones) strain derived from a child with diarrhea (*5*) is the prototype; other strains belonging to this type are those derived from an epidemic of rhinitis in chimpanzees (*4, 13, 19, 21, 22*), a strain (SV-59) (*8*) recovered from the lung of a monkey which died of pneumonia (*13, 22*), a strain ("Amy") recovered from a child with steatorrheic enteritis (*4, 13, 21*), a strain recovered from a healthy child in Mexico, and two strains recovered in a Washington, D.C., nursery by Rosen (*22*).

For the type 3 prototype we (*13, 21*) have selected the "Dearing" strain derived from a child with diarrhea (*5*), and one other strain (BVA 6) in our collection, derived from a healthy child in Mexico, belonged to this type. Rosen (*22*) independently discovered a third type and has used the "Abney" strain, which was isolated from a child with a febrile upper-respiratory infection and was representative of 12 strains recovered from children in a Washington, D.C., nursery, as the prototype of type 3. We (*13, 21*) have found that our two type 3 strains and the "Abney" strain are serologically identical. Rosen and Abinanti (*9*) recovered four type 3 strains from naturally infected cattle.

Table 1. Homotypic and heterotypic hemagglutination-inhibition antibody titers of three types of reovirus rabbit antisera. The rabbit sera were adsorbed with human group O erythocytes and with kaolin prior to their use in hemagglutination-inhibition tests.

Virus		Antiserum			
Type	Strain	Lang (type 1)	D 5 (type 2)	Dearing (type 3)	Abney (type 3)
1	Lang	*2560*	40	10	80
2	D 5	10	*1280*	20	20
3	Dearing	40	40;160	*2560*	2560
3	Abney	160	160	5120	*5120*

Conclusion

The reoviruses, a new group of cytopathogenic viruses made up of the former ECHO type 10 virus and of others antigenically related to it, are distinct in their properties from all other known viruses. The optimum medium for their isolation is monkey-kidney tissue culture. They have been recovered from human beings, chimpanzees, monkeys, and calves, and serologic data suggest that guinea pigs, rabbits, dogs, and cats may also be naturally infected. Their size of approximately 72 mμ, as measured by gradocol membrane filtration, is somewhat smaller than that of the myxoviruses, the adenoviruses, and the CCA (chimpanzee coryza agent) or RS (respiratory syncytial) virus (*23*) and distinctly larger than the enteroviruses. The reoviruses are ether-resistant, like the adenoviruses, with which they share an affinity for both the respiratory and the enteric tracts, and unlike the myxoviruses and the RS virus, which have an affinity predominantly for the respiratory tract and are readily destroyed by ether. The cytoplasmic inclusion produced by the reoviruses is distinctive. The great sensitivity of the reovirus, human group O hemagglutinin to destruction by periodate and its resistance to RDE is another distinctive property. The capacity of all reoviruses to multiply in newborn mice, with the production, by large doses of some strains, of clinical manifestations and lesions in the brain, myocardium, liver, and pancreas similar to those produced by the Coxsackie B viruses, at first suggested a possible relationship to this group of viruses (*10, 12*), but many other properties, most particularly their large size, clearly distinguish the reoviruses from the Coxsackie viruses (*24*). The association of various reoviruses with respiratory and enteric illness in human beings, chimpanzees, and monkeys points to the necessity of including the reoviruses in any systematic study of the complex viral etiology of respiratory and enteric diseases of human beings. The capacity of reoviruses to produce lesions in the brain, liver, and myocardium of newborn mice also points to the need for considering them as a potential cause of similar lesions in reovirus infections of newborn children (*25*).

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24. The committee on enteroviruses of the National Foundation considered the data presented in this article and unanimously voted to remove the ECHO type 10 virus from the group of enteroviruses.

25. The personal studies reported in this article were aided by grants from the National Foundation.

Report of the Special Committee

A suggestion for simplifying a procedure, now almost traditional, by which various agencies reach decisions.

Warren Weaver

Various organizations—foundations, government agencies, research institutes, universities—from time to time face the question: Should we or should we not undertake a new or a much larger and more intensified program of activity "X." Now *X* may stand for "the design and construction of a much larger, faster, and more flexible computer," or "a crash attack on cancer," or "an adequate program in oceanography," or "the building of a larger radio telescope," or "structural studies of proteins," or the production of "a higher energy linear accelerator," or "long-range studies of the genetic effects of x-rays," or "boring a hole through the earth's crust," or "arctic and antarctic research," or "a large new attack on atmospheric physics," or "an improved program for mental health," or "the conquest of space," or—well, you get the idea.

A common procedure is to set up a Special Committee of experts on *X* in order to find out whether *X* is a good idea. This committee is, characteristically, national or even international in scope, is formed of external experts of recognized standing (external as regards the agency in question but most emphatically internal as regards *X*), and always contains a comforting proportion of what might be called right names. These are men intensively interested in *X*, often with lifelong dedication to *X*, and sometimes with a recognizably fanatic concentration of interest on *X*. Quite clearly, they are just the lads to ask if you want to know whether *X* is a good idea.

To support the work of this committee, an appropriation is obtained, ranging from, say, $10,000 to $25,000, in the case of timid and inexperienced groups, to $200,000 to $500,000 or more in the case of far-sighted and imaginative groups.

This money is used by the Special Committee to finance a "Feasibility Study."

Each such feasibility study results, after a period of months or even years, in a Report. This Report usually opens or closes with a short Summary Report, and also includes a long and impressive technical section, complete with charts, tables, quotations, footnotes, and so on.

This now almost standard procedure requires both time and money. It is, furthermore, embarrassingly true that those at the decision level may be impressed, but seldom are enlightened, by the long technical section, and therefore they usually have to depend largely on the Summary Report.

Having arrived at this point in describing the procedure of special committees to study the feasibility and importance of placing more emphasis on *X*, one is suddenly struck with an idea. Could this whole procedure not be simplified, made more prompt, more efficient, and less expensive?

Having had the unusual privilege of reading a good many such documents, I would like to suggest the possibility that, at least in many instances, these special committees, and their feasibility studies, can be eliminated entirely.

This does, of course, involve foreswearing the intellectual luxury of the long Technical Appendix. (Many years ago the then president of the University of Virginia, Edwin A. Alderman, described a *tea* as a social event designed to give minimum pleasure to the maximum number of persons. The Technical Appendix to a report stands at the other end of the spectrum, since it gives maximum pleasure to the minimum number of persons. In certain limiting cases of what might be called a "Pure Technical Appendix," the contents give extreme pleasure, but to the author only.) The shorter procedure, which I wish to suggest, consists of utilizing a standard, universal form (presently to be available at 2 cents a copy in lots of ten or more) for the Summary Report.

To indicate the practicality of this procedure, I venture to suggest here a tentative draft for such a universal Summary Report. It can be adapted to a very wide variety of circumstances, simply by replacing *X* by a word or phrase suitable to the special case in hand.

Summary Report of Special Committee on *X*

1) This is a scientific field of critical importance, with obvious and widely ramified interconnection with national defense and with the health of our national economy. The intellectual and esthetic importance of deepening our knowledge in this area cannot be over-emphasized.

2) This field has been meagerly supported in the past. And there is every reason to expect that modest but suitable financial support (say, roughly 20 times the present level) could lead promptly to results of the highest significance.

3) There is ample evidence that recent scientific leads and exciting new experimental techniques are now available which combine to make the present moment a particularly fortunate and promising one for undertaking an energetic attack.

4) The long and careful study which your committee has carried out has resulted in assigning a very high priority to *X*. A substantial development must proceed without delay if we are to capitalize on the enthusiasm of the experts who are devoted to this field, and who have developed a momentum which is a great present asset, but which might decay rapidly if encouragement is not promptly supplied.

5) Your Committee deeply deplores—indeed condemns—international rivalries in science. But we nevertheless feel compelled to point out that the Russians appear to be, in this field *X*, well ahead of us.

6) Your Committee thus recommends the immediate creation of a National Institute on *X* [the forms will provide space here for other terminology, but it is expected that the phrase given will serve in most instances], together with a broad program of research grants, fellowships, travel grants, and so on [here again, there may be exceptional instances which will require minor changes in wording], to be carried out . . . [the form will offer an assortment of phrases here, from which the users may choose; for example, "in all suitable institutions," throughout the waters of the

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oceans of this planet," "within the deep core of the earth," "in the arctic and antarctic areas," "throughout the troposphere," "in space," etc., etc.]. Your Committee estimates that roughly one hundred million dollars will be needed for initial capital facilities, including $850,000 for architects' fees, plus annual operating sums of ten to thirty million dollars [these estimates are necessarily preliminary—that is, too small].

In conclusion, it may usefully be remarked that when the Summary Report of the Special Committee is transmitted by operating officers to their governing boards, it is traditional to make some such statement as: "It will be recognized at once that the members of the Special Committee which rendered this admirable and challenging report are scientists of the highest standing, with broad and impressive experience. As the leading experts in the field *X*, the competence of their judgments on this topic cannot be challenged. It seems difficult indeed to see how we can afford to disregard their firm and constructive recommendations."

As a final note of caution, it should perhaps be pointed out that this procedure of concentrating attention on one single field, and utilizing the advice of those already committed to it, does have its complications. If one permits oneself to fall in love, one at a time, with a sequence of individually glamorous ladies, it is difficult to avoid multiple bigamy.

In addition to those who quite naturally consider *X* to be of first priority, there are equally competent groups who would assign the same top priority to *A*, *B*, *C*, . . . *Z*. If there is, in fact, a finite and limited amount of money available nationally for science, who is it that sits down on a hard chair and soberly weighs the alternatives? Is there a Special Committee for this?

V. Korenchevsky, Father of Gerontology

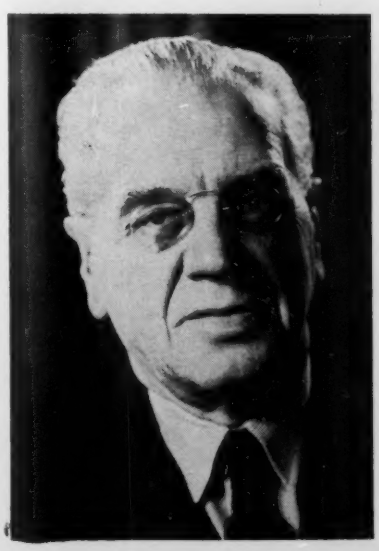
V. Korenchevsky's life was a gift from Russia to humanity of far-reaching consequences. He was the pioneer in the investigation of the problems of aging which have now grown to be of such gigantic proportions.

In 1880 he was born in Lida, Russia. It was apparently from his mother that he inherited his fighting qualities. He graduated from the Imperial Medical Academy in Petrograd in 1903. After having served as head of a military chemicobacteriological laboratory in Manchuria during the Russo-Japanese War, he visited in 1906 a Russian infirmary for old people in Moscow. He was appalled by their premature and abnormal aging. He tried to estimate the human wastage by comparing these unfortunates with others who enjoyed healthier, more useful, and longer lives. He pictured to himself what they might have been. His life during the next 53 years was one of striving somehow to discover how people can best be enabled to realize their full potentialities in their later years.

But after the Russo-Japanese War life for him became very unsettled. He worked, however, toward his goal, with Mechnickov in Paris on gastrointestinal autointoxication and with Pavlov in the Institute of Experimental Medicine in Petrograd, where he was appointed professor of experimental pathology in 1911. He devoted himself mainly to the effects of sex and thyroid hormones on somatic organs and their functions. He was obviously bringing to bear on the problems of aging the rapidly developing science of endocrinology when he was suddenly condemned to "liquidation" in 1919. He escaped to the White Army, fighting in Southern Russia; after the defeat of this army he emigrated to Britain and became a naturalized British subject.

In Britain Korenchevsky continued his important investigations in the Lister Institute of Preventive Medicine in London, in a special laboratory provided for him in Oxford, and in the department of physiology of St. Bartholomew's Hospital Medical School in London until his retirement in 1952 at the age of 72. He soon discovered that the sex hormones have manifold effects on somatic tissues and probably on the processes of aging. He investigated antagonistic hormones and their actions, the accelerating effects of gonadectomy on aging, and the antiaging properties of androsterone and testosterone propionate. Above all he tried, with some success, to devise objective tests for the processes of aging. His was a dynamic personality. He attracted people to work with him, and he helped them enormously. His view expanded into an appreciation of gerontology as a superscience depending on the basic sciences of anatomy, pathology, physiology, biology, biochemistry, psychology, sociology, and others, and he distinguished gerontology sharply from geriatrics, which is the general practice of medicine with old people, just as pediatrics is the general practice of medicine with young people.

Korenchevsky's greatest service to humanity was in the world-wide promotion of gerontology. In this he received much assistance from perhaps the greatest of Britain's millionaire phil-



V. Korenchevsky

anthropists, Lord Nuffield, and Korenchevsky probably encouraged Lord Nuffield to advise his Foundation to enter this field. Exactly how this friendship and teamwork started I do not know, but I have observed the two men together in conference, and I have taken a small part in the discussions. I think that it was for Lord Nuffield that Korenchevsky compiled and had printed the first world list of gerontological societies and their members. His was the organizing drive behind the First International Gerontological Congress in 1950. On the invitation of L. Brull, this was held in Liège, and Brull served as first president. Members of the congress were the gerontological societies mobilized by Korenchevsky, together with some additional ones. All those present at the congress unanimously voted Korenchevsky the most important posts they could think of, which were life member of the governing body and founder of the International Association of Gerontology. He became in truth "the father of gerontology," not simply in Britain but in the whole world.

Korenchevsky retired from active work in his laboratory in 1952 and thereafter devoted himself entirely to the promotion of gerontological research everywhere and to the writing of his book. This advancement of gerontological research involved three trips to the United States and much traveling and correspondence in Europe. He attended the second congress, in St. Louis, in 1951 and the third congress, in London, in 1954. He was unable, much to the disappointment of his followers, to participate in the fourth congress, in Merano, Italy, in 1957.

His book, entitled *Physiological and Pathological Aging*, is really a summarization of his whole life's work in this field. It reveals the great gap between physiological, or normal, aging under the best possible conditions and the terrible state of pathological aging under very adverse conditions which attracted his notice back in 1906. Like his close associate Anton J. Carlson, he believed that there is no other domain of human knowledge in which application to human welfare lags so far behind discovery. The book has been completed and it awaits publication.

Korenchevsky's married life was a very happy one and endured for 52 years. Rose-growing was his hobby. He used to say that each flower was like a patient needing special attention. In his meditations he could have had the satisfaction of feeling that he had fathered developing gerontology through its graduation as a science. He left to others the task of assisting the young science to gain stature and recognition so that, before long, it will be included in its own right by universities among their scientific departments.

In his later days Korenchevsky was troubled by angina pectoris; the attacks became more frequent and severe, and he finally died, suddenly, painlessly, and mercifully, on 9 July 1959. He is survived by his wife and two daughters.

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Science in the News

House Committee on Un-American Activities Continues to Investigate Education

The House Committee on Un-American Activities is showing a continuing concern for American education. Recent action in two major cases is receiving the attention of the academic community. The Supreme Court refused a rehearing for Lloyd Barenblatt, former psychology instructor at Vassar College who was convicted of contempt of Congress because he would not discuss with congressional investigators an accusation that he had once been a Communist. One hundred and ten California school teachers were subpoenaed by the House Committee for questioning about their possible Communist affiliations.

The Barenblatt Case

Lloyd Barenblatt was teaching psychology at Vassar College when he received a summons to appear before the House Committee on Un-American Activities in May 1954. A month later his 4-year contract at Vassar expired and was not renewed. At the committee hearings, an acknowledged former Communist reported that Barenblatt had been a member of the Communist Party while he was a graduate student at the University of Michigan. Barenblatt, on First Amendment grounds, refused to discuss the witness's testimony, arguing that however he answered questions relating to membership in the Communist Party, his position in society and his ability to earn a living would be seriously jeopardized. He pointed out, further, that this would occur even if he did no more than invoke the protection of the Bill of Rights.

He was convicted of contempt of Congress, which led to a $250 fine and a 6-month prison sentence. Last June the Supreme Court upheld the conviction in a 5-4 decision, and on 12 October a petition for rehearing was rejected. Barenblatt surrendered to District of Columbia authorities on 10 November and is now in the D.C. jail.

The American Civil Liberties Union conducted Barenblatt's case, as it has a number of similar ones, in an effort to test the constitutionality of the House Committee's activities.

Balancing Doctrine Questioned

In the decision last June, the Supreme Court ruled that legislative investiga-

tions into communism were proper because the nation's interest in defending itself against communism was greater than the individual's interest in not disclosing his political associations. The Civil Liberties Union's recent rehearing petition held that this judicial balancing doctrine needs further examination and pointed out that, prior to the Barenblatt decision, "it had been settled constitutional doctrine that freedom of speech and association, expressly protected . . . against any governmental infringement, has a special constitutional status not subject to being outweighed except by a proved most compelling interest." In his dissent Justice Hugo Black said of the balancing test: "I do not agree that laws directly abridging First Amendment freedoms can be justified by a congressional or judicial balancing process."

Another part of the minority opinion held that the committee itself, as well as its activities, is unconstitutional. After emphasizing that the court's ruling gave sanction to the use of the contempt power to enforce questioning by congressional committees in the realm of speech and association, Black outlined the constitutional violations in the case as follows:

"(1) Rule XI creating the Committee authorizes such a sweeping, unlimited, all-inclusive and undiscriminating compulsory examination of witnesses in the field of speech, press, petition and assembly that it violates the procedural requirements of the Due Process Clause of the Fifth Amendment. (2) Compelling an answer to the questions asked Barenblatt abridges freedom of speech and association in contravention of the First Amendment. (3) The Committee proceedings were part of a legislative program to stigmatize and punish by public identification and exposure all witnesses considered by the Committee to be guilty of Communist affiliations, as well as all witnesses who refused to answer Committee questions on constitutional grounds; the Committee was thus improperly seeking to try, convict, and punish suspects, a task which the Constitution expressly denies to Congress and grants exclusively to the courts, to be exercised by them only after indictment and in full compliance with all the safeguards provided by the Bill of Rights."

California Teachers Subpoenaed

Many observers interpreted the Barenblatt decision as an endorsement of the work of the House Un-American Activities Committee, which has continued its investigation of education. Last February the committee announced plans to study the extent of Communist influence among faculty members of public and private schools in California. Hearings were scheduled for the end of the month, and 30 subpoenas were issued, including five to Los Angeles teachers. An injunction suit that challenged the validity of the subpoenas was filed in federal court, and several organizations in the state opposed the committee's activities from the start as a "needless harassment." Nevertheless, the hearings were held; on the second day, however, Committee Chairman Francis Walter cancelled the teacher subpoenas, saying that the committee did not want to go about the investigation in education on a "piecemeal" basis and that "at least three dozen teachers . . . a barn full . . . will be called when we come back to Los Angeles."

On 5 June the committee served 110 subpoenas on California school teachers —70 in southern California and 40 in northern California—for hearings on 12 June in San Francisco and 24 June in Los Angeles. (The names of those served in northern California were released to the press.) A week later the committee postponed the hearings until September, stating, "The ramifications of the Communist operation in California are so extensive and malignant that additional investigative work must be done before the actual hearings can be held."

During August the hearings were first posponed again until October and then were cancelled. At that time the committee reported that the names of the subpoenaed teachers and any data about them that could be disclosed without jeopardizing sources or security procedures would be turned over to California school officials.

The American Civil Liberties Union immediately appealed to the federal court to prevent this, saying that much of the committee's material is "unsworn, unevaluated data from unidentified informants concerning political and social beliefs, opinions and associations that would be used to punish the plaintiff teachers in the attempt to cause them loss of employment and to harass them." Before any restraining order could be issued, a House Committee investigator delivered the files on 93 of the teachers to the state superintendent of public instruction. Subsequently, the material was sent to the state attorney general, and it is reported that he in turn has distributed the records to various county district attorneys and boards of education.

Public Protest

Meanwhile, the public opposition grew, and on 22 September chairman Walter threatened to have his committee return to California and reopen the hearings "if responsible authorities in California 'pigeonhole' or in any other manner attempt to suppress committee findings on Communist activities." California district attorneys and school officials are apparently following the advice of the state attorney general, issued on 18 September, to the effect that "no legal or administrative bodies in any of the Counties [should] take any irrevocable action regarding teachers while court cases are pending" in order that they should not "permit themselves to be placed in a position of technically evading federal or state court decisions or of being used to render pending court cases moot." A number of lawsuits have been filed by the subpoenaed teachers. Four of these suits are now pending before the federal and superior courts in California.

Public protests against the House Committee hearings have come from churches, labor groups, newspapers, political organizations, professional teacher societies, and civil liberties and community groups. While responsibility for the cancellation of the hearings was widely distributed, the primary opposition stemmed from the leadership of the subpoenaed teachers themselves through their Northern and Southern California Teacher Defense Committees.

The Barenblatt decision seemed to some observers to give the House Committee on Un-American Activities *carte blanche*, especially in dealing with teachers. This effect has been at least partly offset by the cancellation of the California hearings.

Darwin Centennial Celebration Being Held at University of Chicago

An international Darwin Centennial Celebration will be held next week at the University of Chicago, through the cooperation of the National Science Foundation, the Wenner-Gren Foundation for Anthropological Research, and

the National Institutes of Health. Commemorating the impact of Darwin's theory of evolution on scientific thought, the celebration will open on 24 November, the centenary of the publication of the *Origin of Species*, and continue through 28 November.

The meeting will bring together leading figures in the social and biological sciences to discuss the evolution of life, of man, and of the mind. Centering on common problems that cut across disciplinary lines, the discussions will comprise a series of five 3-hour public panels. These will be devoted to the origin and nature of life, the evolution of life, man as a biological organism, the origin and nature of mind, and social and cultural evolution. Each panel will trace the growth, over the past 100 years, in man's understanding of the processes of evolution; forecast trends of research and thought in the century to come; and appraise the significance of such trends for mankind.

The discussions will be presented by 50 specialists on biological and cultural evolution, who will assemble in five sections to form the panels. Anthropologists, biologists, and psychologists predominate among the participants, who represent the widely varied areas of thought most influenced by the theory of evolution. Thirty-six of the participants are American. The 14 foreign members of the group are: Francois Bordes, University of Bordeaux; MacDonald Critchley, National Hospital, London; Sir Charles Darwin, retired head of Britain's National Physical Laboratory; E. B. Ford, Oxford University; G. F. Gause, Academy of Medical Sciences, Moscow; Sir Julian Huxley, England; L. S. B. Leakey, Coryndon Memorial Museum, Nairobi, Kenya; A. J. Nicholson, Commonwealth Scientific and Industrial Research Organization, Canberra, Australia; Stuart Piggott, University of Edinburgh; Fred Polak, University of Rotterdam; N. Tinbergen, Oxford University; Alexander von Muralt, University of Berne; and C. H. Waddington, University of Edinburgh.

Supplementary Programs

In addition to the panel discussions which form its core, the celebration will include supplementary programs for special groups, as well as ceremonies and social events.

The University of Chicago's department of education has arranged a conference for high-school science teachers. The improvement of biology and science courses at the high-school level and changes needed in the current science curriculum will be the major concerns of this group, which will explore the effects on traditional biology of findings from paleontology, psychology, and anthropology.

During the celebration the Federated Theological Faculty of the University will hold an Institute on Science and Theology. The institute will include lectures on the philosophical and theological implications of the theory of evolution, and a panel discussion to examine the relation of science and religion.

The centennial day will be celebrated with a dinner sponsored by the University of Chicago Citizens Board. After a welcome by Lawrence A. Kimpton, chancellor of the university, an introduction to the celebration will be given by Sol Tax, chairman of the committee, and Sir Charles Darwin, Darwin's grandson and a theoretical physicist and mathematician, will give an illustrated lecture about the voyage of the *Beagle*.

The program for Thanksgiving Day includes a special convocation at Rockefeller Memorial Chapel, with an address by Sir Julian Huxley, and the first performance of *Time Will Tell*, an original musical play based on Darwin's life.

International Atomic Agency Reports Year's Activities

This month the International Atomic Energy Agency submitted its annual report to the United Nations General Assembly. The report is the first to cover a full operational year for the IAEA. It reviews the period 1 July 1958 to 30 June 1959 and is brought up to date by a preface.

Technical Assistance Expanded

Developments cited in the annual report include these, among others:

Sixty-two requests for technical assistance covering a "wide range of activities" have been received so far, and as of 15 September the agency was in the process of carrying out 46 of them. The organization's experts are in the field, and equipment has been supplied in connection with several of the projects.

Preliminary assistance missions from the agency have visited, on request, a number of countries in Southeast Asia, the Far East, and Latin America. Another team left for countries in the Mediterranean and the Near East on 12 October, and smaller missions have visited Greece, Morocco, Tunisia, and the United Arab Republic.

Regulatory Activities Progress

In the regulatory field, considerable progress was made last year, the annual report indicates. A manual on the safe handling of radioisotopes was approved and will be followed in 1960 by a manual on the safe operation of critical assemblies and small research reactors. The agency, together with Yugoslav authorities, is writing a report on an accident at Vinca in October 1958.

Two agency panels are working on problems connected with the transport of radioisotopes and large radiation sources, such as irradiated fuel elements. Another panel has almost completed its draft recommendation on the disposal of radioactive wastes in the sea, and the whole range of waste disposal problems is being discussed at a scientific conference organized by the agency in Monaco and being held this month in Monaco with the United Nations Education, Scientific, and Cultural Organization as cosponsor.

A draft convention on civil liability and state responsibility for nuclear hazards has been drafted by a group of international lawyers convened by the agency.

The guiding principles for a system of safeguards against diversion of nuclear materials to noncivilian ends have been provisionally approved by the Board of Governors. Detailed regulations will now be worked out on the basis of these principles.

Conferences and Publications Sponsored

A series of scientific conferences has been initiated by the agency. The first, held in Vienna in February 1959 and cosponsored by the World Health Organization, dealt with radioisotope-scanning techniques for medical purposes. Other conferences have dealt with the use of large radiation sources in industry (Warsaw, September 1959), the collection and analysis of small amounts of radioactive materials (Vienna, June 1959), training and education in nuclear energy (together with UNESCO, Saclay, France, July 1959), radioisotope teletherapy units (with the World Health Organization,

Vienna, August 1959), and the measurement of radioisotopes (Vienna, October 1959).

The agency's first scientific and technical publications appeared in 1959 and included world directories of power reactors and radioisotopes.

Research Programs Advance

The ground for the agency's functional laboratory near Vienna was broken during the third regular session of the conference in September. Work on the standardization of radioisotopes and radiochemical analysis of food samples (milk) from various countries continue in the provisional laboratory at headquarters.

As of 31 August, 22 research contracts had been awarded by the agency. They deal with health and safety, waste disposal, and safeguards problems, and also with the production and utilization of isotopes.

Soviet-U.S. Cooperation Pledged

The preface of the report also draws attention to the announcement, made in September, that the U.S.S.R. and the United States have agreed to use the agency as the means of making available to interested nations all useful information developed by the two countries on the peaceful uses of atomic energy.

In restating the agency's main objectives, the report drafted by the Board of Governors and approved by the General Conference states: "In the broadest terms, the production of radioisotopes and their use in industry, agriculture, medicine and research, and the eventual production of economic nuclear power, under safe and secure conditions, continue to be the main objectives of most of the Agency's work. For the attainment of these aims the Agency is now employing a variety of means, including technical assistance, the diffusion of information, the formulation of regulations and recommendations, the supply of nuclear fuels, the promotion of research reactor development, the elaboration of safeguards, the organization of training courses, the award of fellowships and of research contracts."

IAEA membership has risen to 70. The agency works in relationship with the United Nations under a special agreement, and it participates in the Expanded Program of Technical Assistance of the U.N. and related agencies

Confirmation of the Rydberg Constant

The accepted value for an important atomic constant, the Rydberg constant, has recently been substantiated by the National Bureau of Standards. This confirmation resulted from an examination of earlier work which gave a value in conflict with the Rydberg constant in use today. After re-evaluating the basis for this determination, W. C. Martin of the bureau staff recalculated the constant and obtained excellent agreement with the accepted value.

In the picture shown here, Martin is aligning the projecting lens of a system used in measurements to re-evaluate the Rydberg constant. The work involves measuring the wavelength of the 5016-A helium line against a mercury standard. Light from a liquid-nitrogen-cooled helium lamp, immersed in Dewar (lower right), equipped with windows, passes through a partially transmitting mirror into the interferometer along with light from the mercury-198 lamp (lower center), which is reflected into the interferometer by the same mirror. The resulting fringes are then projected onto the slit of a large prism spectrograph (upper left). A comparison of the helium fringes thus obtained with the fringes due to mercury lines of known wavelength allows a very accurate determination of the wavelength of the particular helium line involved in calculating the Rydberg constant.

This evaluation was carried out as part of a broader program which seeks to obtain more accurate values for important physical constants, such as velocity of light, acceleration of gravity, and various atomic constants.

W. C. Martin of the National Bureau of Standards aligning the projecting lens of a system used in measurements to re-evaluate the Rydberg constant.

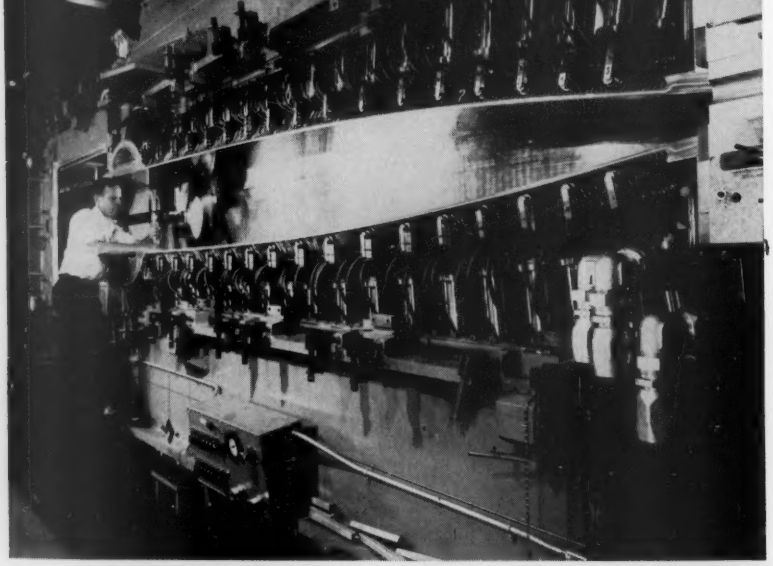
Wind Tunnel Announced

A new $3.5 million continuous-flow hypersonic wind tunnel that can generate air speeds 9 times the speed of sound is operating at the California Institute of Technology's Jet Propulsion Laboratory in Pasadena, a research unit of the National Aeronautics and Space Administration. Supported by the U.S. Army Ordnance Corps, JPL's new aerodynamic facility is one of the first hypersonic wind tunnels in the United States that can engage in missile-development testing on a high-production basis.

The tunnel, the third installed at JPL since 1947, took about 3½ years to build. The preliminary design and fabrication specifications were developed by JPL engineers, and detailed design, fabrication, and erection were carried out by the Westinghouse Corporation. Use of the facility is divided equally among NASA research programs, Army weapon development, and Air Force weapon development.

The outstanding feature of the new tunnel is its flexible, two-dimensional nozzle, the design of which was based on the experience gained by JPL from its earlier tunnels. The two tapering stainless steel plates, which can be seen in the accompanying picture at the top and bottom of the nozzle, can be adjusted to the contour of test forms by a system of 16 hydraulic jacks.

A characteristic that distinguishes this tunnel from a conventional supersonic tunnel is that the air must be heated before it is introduced into the nozzle in order to prevent the formation of droplets of liquid air. Therefore, a 4200-kilowatt-electric heater was placed between the compressors and the supply section, so designed that it would be able to boost the temperature of the air coming in from the compressor from 150° to as high as 1350° F.



A downstream view of the nozzle of the C.I.T. Jet Propulsion Laboratory's new hypersonic wind tunnel shows a JPL technician checking the position of the calibration probe used to measure the aerodynamic characteristics of the tunnel.

Materials Study To Be Expanded

Government-supported research on materials for the space age will be expanded in coming years. Plans for the expansion are currently being prepared by a number of government agencies. The action follows recommendations by both the President's Science Advisory Committee and a committee of the National Academy of Sciences.

Behind the new effort is the conviction of many scientists that the need for high-strength, heat-and corrosion-resistant materials, particularly metals, must be met before advances in the use of atomic power and in space exploration can be made. In the view of some authorities, technological needs in the last decade have expanded faster than research activities on materials, and existing materials are being pushed to the limits of their capabilities.

The need and the problems it poses were examined recently by A. J. Hertzig, president of the Climax Molybdenum Co. and chairman of the materials advisory board of the National Research Council: "From the point of view of the materials worker it is difficult to understand why so much support is forthcoming toward the design of equipment for which no suitable materials are yet known, whereas support for materials research and development comes in similar intensity only when end-item pressure is upon us."

Hertzig's statement reflects a concern shared by government scientists. Recently, both the President's Advisory Committee and the Federal Council on Science and Technology have given increased attention to the problem of materials research. Last spring an interdepartmental committee, headed by John H. Williams of the Atomic Energy Commission, was set up to study the materials problem and give periodic reports to the Council.

The deliberations of these two committees, together with the work of the NAS committee, have resulted in a governmental move toward expanded materials research as well as a program for carrying out this research by the many federal agencies directly interested in materials development. Both the National Bureau of Standards and the Department of Defense have recently increased research activities in the field. Last June, the Department of Defense, noting that materials represented a "serious limiting factor" in the development of new weapons, allocated $15 millions for university research on materials. Similarly, the National Bureau of Standards has intensified its work on the properties of metals and other substances.

News Briefs

Columbia University has concluded an agreement for an exchange of professors with Moscow University. The agreement, for 1 year on an experimental basis, is one of the first arrangements for a professorial exchange between Soviet and United States universities. An exchange of graduate students between the two countries is now in its second year.

Last May Harvard University an-

nounced a tentative agreement for an exchange of professors with Leningrad University. It was then hoped that the arrangement would be in operation by September. However, the university has yet to receive specific exchange proposals from Leningrad.

* * *

The first international institute for experimental research in gerontology has been established, at the University of Basle. F. Verzar of the university will direct research work, which will be concentrated on the aging of the tissues of small animals.

* * *

A regional training course on the use of radioisotopes in agricultural research will be held at the Indian Agricultural Research Institute, New Delhi, from 20 January to 17 February 1960. The course has been organized jointly by the Government of India, the Food and Agriculture Organization, the International Atomic Energy Agency, and the United Nations Educational, Scientific, and Cultural Organization. Inquiries should be addressed to the UNESCO South Asia Science Co-operation Office, 21, Curzon Road, New Delhi, India.

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The Camille and Henry Dreyfus Foundation has made a grant of $25 million for the establishment of an international center for polymer chemistry at North Carolina's new Research Triangle Institute. The research center will be known as the Camille Dreyfus Laboratory, in memory of Camille Dreyfus, who was the founder and first president of Celanese Corporation of America. It will be located on Research Triangle Institute's 200-acre campus in the 4500-acre Research Triangle Park. The park, now being developed as a center for research laboratories, is within 15 miles of the University of North Carolina, Duke University, and North Carolina State College, respectively.

* * *

The National Science Foundation has released *Current Projects on the Economic and Other Impacts of Scientific Research and Development, 1959*, which describes the nature, objectives, scope, and principal research methods of a group of studies being conducted by United States colleges and universities. A summary of each of the 107 projects is presented, together with the names and academic affiliations of the investigators and the anticipated form of publication of the research results. Simultaneously, the foundation released *Bibliography on the Economic and Social Implications of Scientific Research and Development*, a selected, annotated compilation of references to studies of scientific research and development. Copies of both publications are available from the Superintendent of Documents, Government Printing Office, Washington, D.C., at a cost of 25 cents each.

Scientists in the News

Sir Edward Bullard, Adolph Knopf, and **Jack L. Hough** were awarded the Geological Society of America's highest honors at the society's annual dinner on 3 November in Pittsburgh, Pa. They received, respectively, the Arthur S. Day Medal, the Penrose Medal, and the Kirk Bryan Award.

Nelson Marshall, formerly dean of liberal arts at Alfred University, has been appointed administrative associate and professor of biological oceanography at the Narragansett Marine Laboratory of the University of Rhode Island. He will also serve as dean of summer session at the university. **Harry P. Jeffries**, formerly of Rutgers University, has been appointed associate oceanographer and assistant professor of biological oceanography at the laboratory.

Paul Woldstedt of the Geological Institute of the University of Bonn is currently research associate in the geology department at the University of Minnesota. He is visiting a number of universities and research centers to present lectures on the European Pleistocene and to participate in field excursions.

John J. Willaman of the U.S. Department of Agriculture retired last month. Since 1940 he has been in charge of research on fruits, vegetables, tobacco, maple, honey, and wild plants at the Agricultural Research Service's Eastern Utilization Research and Development Division in Wyndmoor, Pa.

Alfred N. Richards, emeritus professor of pharmacology and former vice president for medical affairs at the University of Pennsylvania, received the Abraham Flexner Award of the Association of American Medical Colleges for "long and distinguished service to medical education" at the association's annual banquet in Chicago, Ill., on 2 November.

Thomas C. Fleming has been appointed medical director of the Warner-Chilcott Laboratories Division of Warner-Lambert Pharmaceutical Company, Morris Plains, N.J. He had been affiliated with Mead, Johnson Company as director of product development.

William H. Guier of the Johns Hopkins University Applied Physics Laboratory was named last month the "outstanding young scientist of Maryland for 1959" by the Maryland Academy of Sciences. He received the award for his use of Doppler-shift calculations to establish a new means of tracking earth satellites. The awards, established this year, will be presented annually to a resident of Maryland under 35 years of age.

Egon Orowan, George Westinghouse professor of mechanical engineering at Massachusetts Institute of Technology, received the Bingham Medal of the Society of Rheology at the 30th anniversary banquet of the society, held 5 November at Lehigh University. He was cited for his contributions to the understanding of the behavior of solids.

Joseph C. Clarke has been appointed manager of the Atomic Energy Commission's New York Operations Office. Clarke, who had served as deputy manager of the New York Office since 1 July 1954, replaces **Merril Eisenbud**, who resigned to accept an appointment as professor of industrial medicine at New York University.

Edward S. Amis, professor of physical chemistry at the University of Arkansas, has won the 1959 Southern Chemist Award of the American Chemical Society's Memphis Section. The gold medal "for distinguished service to the profession of chemistry in the Southern states" was presented at a banquet in Richmond, Va., on 6 November.

Vincent Schultz has joined the Atomic Energy Commission's division of biology and medicine at commission headquarters, Germantown, Md., as an ecologist in the environmental sciences branch. Previously he was employed at the University of Maryland as a consulting statistician and associate professor of biostatistics.

Margaret J. Carlson, formerly a supervisory bacteriologist for the Army Institute for Research of the Walter Reed Army Medical Center, Washing-

ton, D.C., has been appointed executive secretary of the new microbiology training committee in the division of general medical sciences of the National Institutes of Health.

Kurt Berman, manager of liquid propellant engineering at the General Electric Company's Malta Test Station near Schenectady, has been named adjunct professor of aeronautical engineering at Rensselaer Polytechnic Institute.

Irving J. Wolman, hematologist of the Children's Hospital of Philadelphia, has been named chairman of the department of pediatrics at the Graduate School of Medicine, University of Pennsylvania.

Howerde E. Sauberlich, formerly associate professor of animal husbandry at Iowa State University, has been appointed chief of the chemistry section of the Army Medical Research and Nutrition Laboratory, Fitzsimons Army Hospital, Denver, Colo.

Hollis D. Hedberg, president-elect of the Geological Society of America and former vice-president of the Gulf Oil Company, has been appointed professor in the department of geology, Princeton University.

Clark C. Vogel has resigned as deputy director of the division of international affairs of the Atomic Energy Commission, to accept a position with the Martin Company, Baltimore, Md.

Louis L. Ray, on leave from the U.S. Geological Survey, is serving as visiting professor of geology at Cornell University, Ithaca, N.Y., during the academic year 1959–60.

Charles V. Riley has been appointed head of the department of biology at Kent State University, succeeding **Harry A. Cunningham**, who retired from the post on 1 September.

Felix G. Gustafson, emeritus professor of botany at the University of Michigan, has been named 1959 recipient of the Charles Reid Barnes Award, presented annually by the American Society of Plant Physiologists.

Murray Saffran has been appointed associate professor in the department of biochemistry at McGill University. He continues his research at the Allan Memorial Institute.

Col. Adam J. Rapalski was recently appointed commanding officer of the U.S. Army Environmental Health Laboratory at the Army Chemical Center, Md. He replaces **Col. Edward J. Dehne**, who has been assigned as preventive medicine officer, Headquarters, Second U.S. Army, Ft. Meade, Md.

Samuel A. Levine, clinical professor of medicine, emeritus, Harvard Medical School, has received the Gold Heart Award of the American Heart Association for "outstanding achievements in clinical cardiology."

D. L. Thomson, dean of the Faculty of Graduate Studies and vice-principal of McGill University, has retired as chairman of the department of biochemistry. He will continue as a professor in the department. He is succeeded as chairman by **K. A. C. Elliott.**

Alexander I. Petrunkevitch, zoologist at Yale University, was honored 30 October with the university's Addison Emery Verrill Medal for outstanding contributions in the field of natural history.

Henry M. Gelfand, formerly a member of the Tulane University Medical School faculty, has joined the staff of the U.S. Public Health Service's Communicable Disease Center, Atlanta, Ga., as chief of the enterovirus unit, laboratory branch.

Colin Turnbull has been appointed assistant curator of African ethnology at the American Museum of Natural History.

Carl F. Muckenhoupt, formerly chief scientist of the Boston branch office of the Office of Naval Research, has been appointed dean of research administration at Northeastern University.

Mostafa B. Talaat, formerly with the Carrier Corp., has joined the nuclear division of the Martin Company. He will direct all research and development efforts in the field of energy conversion.

Fred B. Seely, member of the University of Illinois faculty and former head of the theoretical and applied mechanics staff, is being honored by the establishment of an award to be given annually to the outstanding senior in the university's new engineering mechanics curriculum. The award includes $100 and a certificate.

Joseph S. Fruton, professor of biochemistry at Yale University, has been appointed director of the university's division of sciences.

Recent Deaths

James P. Atkinson, Valatie, N.Y.; 89; former analytical chemist with the New York City Department of Health; 31 Oct.

Walther Bauersfeld, Heidenheim, Germany; 80; senior director of the Karl Zeiss-Werke optical concern; inventor of the planetarium; 28 Oct.

Werner Bergmann, New Haven, Conn.; 55; professor of chemistry at Yale University; scientific consultant for Yale's Bingham Oceanographic Laboratory and a trustee since 1950 of the Bermuda Biological Station; 2 Nov.

Kenneth W. Chapman, Washington, D.C.; 48; associate director of the clinical center, National Institutes of Health, Bethesda, Md.; 18 Sept.

Lewis V. Heilbrunn, Lovingston, Va.; 67; professor of zoology at the University of Pennsylvania; 24 Oct.

Gustav Land, New Haven, Conn.; 79; research associate in astronomy at Yale University; his career took him to the Astronomisches Rechen Institut in Berlin-Dahlem, the observatories in Königsberg and Leipzig, H. M. Nautical Almanac Office in London, and Sproul Observatory at Swarthmore College; 26 Sept.

Gerald F. Machacek, New York, N.Y.; 62; associate professor of histopathology at the College of Physicians and Surgeons, Columbia University; 8 Nov.

Albert H. Miller, Providence, R.I.; 87; contributor to the field of anesthesiology; 31 Oct.

George P. Rettig, Hoboken, N.J.; 52; assistant professor of civil engineering at Stevens Institute of Technology; 28 Oct.

Laurence F. Schmeckebier, Washington, D.C.; 82; retired senior staff member of the Brookings Institution; author of a number of books on political affairs; 2 Nov.

Francis H. L. Taylor, Winchester, Mass.; 59; biochemist, researcher on blood composition; 31 Oct.

Erratum: The item on Clarence J. Hylander [*Science* **130**, 1244 (1959)] indicated that he left the post of executive director of the American Institute of Biological Sciences to take his current position as visiting professor of biology at Bowdoin College. He last held the AIBS post in 1953; since that time he has been an information officer for the Army Chemical Corps and has written a number of books.

Book Reviews

Mankind in the Making. The story of human evolution. William Howells. Doubleday, Garden City, N.Y., 1959. 382 pp. Illus. $4.95.

Dedicated to the memory of Earnest Hooton, *Mankind in the Making* is a legitimate successor to *Up From the Ape*; indeed, it was born in Hooton's laboratory in the awesome presence of the maestro's skulls. Like his predecessor, Howells is a master of English style, and this is the most civilized piece of anthropological writing I can remember. To accompany it Janis Circulis has drawn over 60 sets of excellent line cuts. Because he worked in Howells' laboratory under close supervision, awkward last-minute changes were eliminated, and the product matches the text. Although the eight plates of photographs are well enough chosen, they somehow break the spell and bring us back to business.

This business consists of tracing human evolution and the origins and movements of living races. The first eight chapters, more than one-third of the text, deal with principles of evolutionary change, general vertebrate paleontology, and primate history through the Australopithecines. Almost miraculously, Howells managed to squeeze in (page 122) a 16-line paragraph on Lewis Leakey's momentous discovery (17 July 1959)—the skull and tiba of a late Lower Pleistocene man, complete with chopping tools and fauna, in Olduvai Gorge, Tanganyika. The appearance of this specimen, dubbed *Zinjanthropus* by Leakey, will trigger-off as much tooth-gnashing and plate-hacking among textbook publishers as the laying of Piltdown's ghost. Howells crept under the wire, but only just. He lacked time to refer to the new man elsewhere in his text. But since Leakey's find fits Howells' reconstruction of hominid history, no harm was done, and the author's logic was, in this sense, fortified.

Sometimes paleontologists and other taxonomists marvel, and sometimes in a lofty way, at the confusions and disagreements among anthropologists over the descent of man, whose bones are scarcer than those of elephants and horses and whose global goings and comings are more widespread and complicated than those of prairie dogs and hornbills. As Howells indicates, the two main schools of thought, among others, interpret the same well-handled roster of fossil human remains in their own ways.

The "candelabra" school, with Weidenreich as its principal protagonist, traces each of the modern human subspecies—such as Australoid, Mongoloid, and the like—among several separate lines from a smaller-brained, chinless ancestor to its contemporary form. This school follows the well-known principles of parallelism and multiple crossings of a single adaptive threshold.

The "hat rack" school postulates the radiation of many related species at successive adaptive levels and the extinction of all but one species at each level. According to this system, all the well-known heavy-browed men of yore —Sinanthropus, Pithecanthropus, Rhodesian, and the like—became extinct, while *Homo sapiens*, who emerged either from one of them or from some undiscovered ancestor, expanded explosively from some unknown breeding-ground to replace all of the old forms and also to people the New World.

After due consideration and much discussion, Howells plumps for the "hat rack" interpretation. In so doing, he agrees with the majority of serious investigators. He differs from many of them, however, in his choice of ancestors for *Homo sapiens*. He accepts Swanscombe, Steinheim, Fontéchevade, and Kanjera, and rejects both the early (Third Interglacial) and the late (Würm I) Neanderthals. Instead of considering the Upper Paleolithic Europeans to be the ancestors of all living races, he makes them a group of invaders from some unknown cradle land—a land from which their equally sapiens (if not sapient) cousins, the ancient Australoids, Negroids, Mongoloids, and so on, spread to their modern loci.

When Howells comes to explain the modern distribution of these races in the world, he gets into serious traffic trouble, and no gendarme-*ex machina* drops out of the sky to straighten it out. In justice to Howells, let me add that few other writers are willing to risk censure by trying to explain the history of human races as a whole, and I know of no one who has done a better job. Still, I disagree with him on three counts.

(i) He has chosen to ignore, or soft-pedal, the resemblances between fossil and living populations in specific areas, resemblances which can hardly be due to chance or conversion.

(ii) He has, in my opinion, paid too little attention in this book to the archeological records of different areas, records which indicate a number of unbroken continuities between the tool-making techniques of certain "extinct" fossil men and their admittedly sapiens successors.

(iii) Although he questions the validity of the old taxonomy which gives fossil men multiple genera and even grants them synchronous separate species, Howells accepts the existence of such mutually noninterbreeding groups as a working hypothesis. This commits him to the thesis of multiple extinctions.

If one admits the importance of local continuities in morphology and culture, and adds Mayr's concept that man is and always has been a single genus which has never had more than one species at a time, then the candelabra and the hat rack theses become reconcilable. Parallel genetic changes in response to parallel cultural evolution, plus peripheral gene flow, occasional invasions, swampings, absorptions, and the reemergences of locally viable characters through natural selection—all this is made possible by acceptance of Mayr's thesis which permits gene exchange between human populations at all known levels. This unsnarls some of the traffic, particularly in Africa and Southern Asia, and allows time for the rise of some of the principal racial differences between living populations.

This critique cannot surprise Howells; what would surprise any anthropologist would be complete agreement on such

a thinly documented subject. Either of us may be right in our view of the descent of man, or we may both be as wrong as some of our predecessors who fumbled brilliantly in even deeper gloom.

In any case, I still consider *Mankind in the Making* the soundest exposition of its subject yet in print. It will be widely read (particularly at $4.95), and its influence should be wide. Some professionals will wish that the publishers had wanted more documentation in footnotes and bibliography and a few more technical terms. Students and fellow-scientists need this book more than other people, and with Howells' style to float these didactic aids, the book-club crowd could have stomached them painlessly. Anyhow it is a much needed and courageous book, and a graceful monument to a great teacher's memory.

CARLETON S. COON
University Museum,
University of Pennsylvania

The Study of Rocks in Thin Section. W. W. Moorhouse. Harper, New York, 1959. xvii + 514 pp. Illus. $8.

This book is described accurately in its preface as "a brief review of the methods of optical mineralogy (with a minimum of optical theory), descriptions of the rock-forming minerals encountered in the more common rocks, identification tables to assist in the identification of these minerals, and descriptions of the common rock types." Although the book often rises considerably above the level of this rather reserved prospectus, many sections lack the data and critical discussions needed by the graduate student, and its greatest value will be for students and geologists who are concerned mainly with naming common rocks.

The book begins with a 36-page chapter on methods of petrographic mineralogy; with the exception of the parts on dispersion and the universal stage, it is reasonably complete. The user of the book will, however, require additional reading or course work in optical mineralogy. The next chapter consists of brief descriptions of 149 minerals. Many of the descriptions contain orientation diagrams and graphs of optical data. Chemical formulas have been omitted from some of the more complex silicates, for example, biotite and hornblende. Each mineral is given a consecutive number which keys it to several determinative tables, and these tables should be very useful to beginners.

The remaining 70 percent of the book consists of systematic descriptions of rocks, beginning with those of the volcanic and hypabyssal realms, proceeding to plutonic, sedimentary, and metamorphic rocks, and concluding with a brief chapter on ores. Each of the four main groups receives about equal space, but the chapters on igneous rocks seem considerably more complete, probably because it is easier to treat these rocks systematically. In any case, the preliminary discussions and classifications of the sedimentary and metamorphic rocks need amplification. For example, the beginner will sorely miss a summary of the sedimentation cycle, a table showing Wentworth's size scale and classes, and a definition and discussion of grain-sorting. In the chapters on metamorphic rocks, the reader is introduced to concepts and names of metamorphic grades and facies, but he is not told how to interpret them from thin sections; furthermore, several triangular facies diagrams are given, but without instructions for their use.

The descriptions of altered rocks and the chapters on metasomatism and ores are rather new in concept and should prove worth while. The 90 photographs of rocks and minerals and the 350 drawings of rocks are excellent, and they combine with a select format to make this an unusually handsome book.

ROBERT R. COMPTON
Department of Geology,
Stanford University

Handbuch der Physik. vol. 53, *Astrophysics IV: Stellar Systems.* S. Flügge, Ed. Springer, Berlin, 1959. viii + 565 pp. Illus. DM. 142.

This work, the fourth of five volumes devoted to astrophysics, or the art of applying terrestrially formulated laws of physics to the universe as observed by both optical and radio means, is concerned with the manner in which stars occur in systems—our own Milky Way galactic system and its subsystems of open and globular clusters (to which more than one-third of the volume is devoted), the myriad galaxies, and in turn, the systems of galaxies. The three earlier volumes in this subseries of the *Handbuch* treated stellar surfaces and binary stars, stellar structure, and the solar system, respectively.

The dynamics of the galaxy, the classical topic on which so many "astronomer-lives" have been spent, is discussed from both observational and theoretical viewpoints in two masterful chapters by Edmondson and Lindblad; despite the very great progress made, it appears that our understanding of the dynamics of our own galaxy-in-rotation is still imperfect.

In the field of galactic structures and dynamics, progress is being materially accelerated by the rapidly growing contributions of the relatively new techniques of radio astronomy. Oort gives, in his chapter, a learned résumé of these contributions, but any summary of this exploding field of research must necessarily be considered a progress report. This also applies to the discussion of the swiftly mounting contributions made by radio techniques to the study of exterior galactic systems, which are treated in the chapters by Hanbury Brown and Mills.

The structure of galaxies is intimately linked with the evolution of stars from dust and gas clouds, and the unique and signal place held by star clusters in this study is ably and comprehensively treated by Helen Sawyer Hogg. A valuable catalog of open and globular star clusters is included.

A large measure of the value of this volume lies in its presentation of a greatly needed, encyclopedic treatment of external galaxies (it is gratifying to note that the old, ambiguous term nebulae applied to galaxies has at last been discarded). A systematic treatment of the classification, morphology, and general physical properties of external galaxies, which includes many excellent photographs, is given by de Vaucouleurs, while Zwicky, in his inimitable style (almost one-half of the references in his ample bibliography are to his own papers), treats the organization of galaxies in multiple and cluster systems, for on a lower level of organization stars often exist in multiple groupings and in star clusters. Zwicky's photographs present impressive examples of physical linkage between galaxies.

The large-scale organization of galaxies is discussed statistically by Neyman and Scott, and the difficult and controversial cosmological aspects of the wealth of observational data are well treated in chapters by McVittie and Heckmann.

Many will regret, with me, that this excellent treatment of the universe of galaxies does not have a word from the dean of galaxy observers, Walter Baade.

The volume is largely in English, but the index is bilingual. The press work is excellent, and I found only a few typographical errors.

J. Allen Hynek
Smithsonian Astrophysical Observatory, Cambridge, Massachusetts

Roman Construction in Italy from Tiberius through the Flavians. Marion Elizabeth Blake. Carnegie Institution of Washington, Washington, D.C., 1959. xvii + 195 pp. Illus. $9.

The present volume is the second part of a basic, three-volume work which will present in considerable detail the history and development of Roman building methods in Italy. The first volume (1947) takes us through the reign of Augustus; now this one guides us through the confusing history of building in the first century A.D.—a period in which builders seem to be striking out in all directions, but without arriving at any truly major discoveries, and only rarely contributing a great architectural monument.

The old saw would have it that Augustus "found Rome of brick and left it of marble." Just how wrong headed this notion is is amply illustrated by Marion Blake's book; for working with marble (except as a veneer) was never greatly interesting to the Romans, nor was their contribution to stone construction ever of major importance. The great Roman advances in building technique were in the use of brick and concrete, and their continued experiments with these combined media prepared the way for the great architectural masterpieces of Trajan and Hadrian, Diocletian and Constantine—masterpieces which remain to be dealt with in the final volume of the series.

The present volume, like its predecessor, is sumptuously published. The footnotes are set along the edges of the pages, opposite the passages to which they refer; there are five separate indexes; and the plates contain over 100 photographs, beautifully reproduced. Yet it is just in these points where cause for complaint can be found. Anyone likely to read this book will expect to find the footnotes at the bottom of the page, and the present method not only wastes paper when the footnotes are sparse, but, when they come thick and fast, there is really not enough room for them. This leaves the impression that footnote information is crowded back into the text, and confuses material which is already hard enough to read. As to the five indexes, I should much prefer them combined. Finally, it seems to me that for illustrating architecture (and thus building) *drawings* are far superior to photographs and should be used even though some photographs must be left out. Let us hope that in the final volume Miss Blake will append a generous portfolio of drawings to illustrate not only that volume but this entire work.

The text itself deserves only praise. The completed work will force us to reassess both the history of Roman architecture and its contribution to architecture in general. This work is fundamental for classicists and medievalists alike and is recommended to anyone interested in architecture and engineering.

J. H. Young
Department of Classics, Johns Hopkins University

Elementary Astronomy. Otto Struve, Beverly Lynds, Helen Pillans. Oxford University Press, New York, 1959. viii + 396 pp. Illus. $7.

Otto Struve, one of our most distinguished and lucid astronomers, has produced an unusual, interesting, and very useful book. Struve was assisted by Beverly Lynds and Helen Pillans. Although the title is *Elementary Astronomy*, the preface as well as the text clearly indicates that this is not another general, descriptive, astronomical text. Instead the book stresses the physics involved in astronomy, especially dynamical and spectroscopic lines of evidence and analysis. It might have been titled "Elementary Astrophysics." This book will be received with pleasure by many instructors and serious students of astronomy and physics.

The student or general reader usually has a difficult time finding how astronomers proceed from their various types of observation to models of the interior of stars, or to general pictures of the structure and history of the galaxy. Of necessity most introductory texts, like a considerable number of popular books, are mainly descriptive. Books at the next level have generally consisted of specialized, and usually rather technical, discussions. For most readers the gap is too great to jump; but this volume will provide a useful bridge. The volume may also be of value to physics students who explore some of the interesting astronomical contexts in which physics is applied. Problems, but not references for further study, are provided at the end of each chapter.

Although the book jacket contends correctly that the volume is "written in readable, non-technical style, the text assumes no previous training in mathematics or physics; calculus and trigonometry have been omitted entirely," a reader who lacks a knowledge of introductory physics will proceed slowly in many sections. In many instances the discussion is more detailed and mathematical, as well as more modern, than that in the well-known *Astronomy* by Russell, Dugan, and Stewart.

The topics discussed range from coordinate systems and fundamental units, through planetary motions and physical conditions, to the sun and its structure, the origin of stellar radiation, the origin of the solar system, the arrangement and motion of stars in space, stellar spectra, clusters, nebulae, binaries, variable stars, galaxies, and relativity, and the book ends with a chapter on telescopes and their accessories. In every instance, as in the discussion of radio astronomical instruments and observations, emphasis is upon the physical principles used by astronomers in constructing their equipment and interpreting their observations.

The 110 halftone illustrations, all closely related to the text, are most attractive despite the use of nonglossy paper for the book. In addition, 181 diagrams and a four-color frontispiece clarify the discussion. Many of the illustrations are especially interesting because they deal with technical points not commonly discussed or illustrated in descriptive texts.

Fletcher G. Watson
Harvard University

On the Pectoral Fin and Shoulder Girdle of the Arthrodires. Erik Stensiö. *Kungliga Svenska Vetenskapsakademiens Handlingar*, vol. 8, No. 1. Almquist and Wiksell, Stockholm, Sweden, 1959. 229 pp. + plates. Kr. 114.

This is another of the important and beautifully illustrated works by a man who has greatly influenced the study of fossil fishes over the past 3½ decades. As the latest in a series of recent studies on the anatomy and classification of the

primitive fish groups, this publication will interest not only the specialist but will also find many readers among vertebrate morphologists generally because it presents some interpretations of one of the great, although poorly documented, events in the development of backboned animals—the origin of paired appendages.

From the meticulous preparation of a superb representation of fossil arthrodires, principally from Silurian and Devonian strata of Europe, many anatomical details of the pectoral girdles and fins of these fishes have been determined. From these facts Erik Stensiö has adduced "more or less arbitrarily" many other structural conditions of both the pectoral skeleton and the associated, soft anatomy. Seemingly interpreted in terms of a hypothetically ideal, paired fin fold, the variously modified, observed parts are divided into five defined and named types of pectoral appendages. These considerations, coupled with unpublished observations on cranial morphology, serve as the bases for a proposed, new phyletic classification of the Arthrodira in which the geologically younger members of the group are postulated as being the structural antecedent of the oldest known forms.

In his introduction, Stensiö expresses the hope that these ideas will stimulate additional study of the morphology and embryonic development of the paired fins of fishes. This desire is already realized. Many of his conclusions are the current subject of heated controversy among a number of the students privileged to examine his fossil materials in Stockholm prior to the publication of this volume.

DAVID H. DUNKLE
U.S. National Museum

The Determination of Molecular Structure. P. J. Wheatley, Oxford University Press, New York, 1959. vii + 263 pp. Illus. $5.60.

The student of molecular structure has long needed a volume of this kind. Prefacing his book with J. E. Wertz's parody-phrase "pursuit of the details of molecular structure and molecular environment is the occupation of all chemists part of the time and part of the chemists all of the time," Wheatley presents "an introductory survey of main physico-chemical methods that have been devised for the determination of molecular structures."

Dedicated pursuit of such a goal gives rise to arbitrary decisions regarding depth versus breadth: a kind of literary uncertainty principle is in operation which necessarily sacrifices the clarity achieved by completeness for wide coverage. Any good survey tries to strike a happy compromise between the two. But the situation is further complicated when the text is regarded as "introductory," because this would appear to call for an attempt toward coherent exposition from fundamentals, conveniently and sufficiently referenced. This, in turn, necessarily implies some length. In this book, the limitations imposed by an "introductory survey," together with a remarkably meager referencing job (for a text apparently intended for students), give rise to the only serious defects, apart from style and a few typographical errors (for example, the mislabeling of axes in Fig. 1 on page 96) apparent in a first reading.

In the chapters on spectroscopic methods, diffraction methods, (covering electron, x-ray, and neutron diffraction), classical stereochemical methods, dipole moments, magnetic methods, and nuclear magnetic resonance, the author ably stresses which methods are most suitable for the structure determination of particular molecules (with many explicit examples) and the kind of information (molecular symmetry and molecular parameters) they can be expected to provide. Emphasis is placed throughout on the scope and limitations of the above methods, and instances are cited where one method may be preferable to another. In most cases, brief descriptions of experimental technique are given; these descriptions are helpful, at times, in understanding the basic physics of the method, but at other times they merely get in the way.

The style is dry without being crisp: in the section on symmetry properties and in the many examples introduced to punctuate a point or to explain by example, a deft touch would have provided welcome relief to the necessary detail.

While clearly written for the mature student with some background in quantum mechanics and atomic and molecular structure, the book will probably prove useful in general for its handy distillation of theory, fundamental working technique, and practical experience. These qualities will be especially useful to anyone interested in quickly picking up a working knowledge of the subjects covered. But again the purposes of the student and the requirements of a handy source for reference would have been better served had the author or publisher referenced the volume more carefully.

BERNARD J. RANSIL
Department of Physics, University of Chicago

Africa. Emil Schulthess. Simon and Schuster, New York, 1959. 384 pp. Illus. $20.

This pictorial volume resulted from the travels of a modern caravan (transported by a small fleet of Willys station wagons with four-wheel drive and cross-country gears) through the heart of the African continent. Schulthess, chief photographer of *Du*, traveled and photographed from the northern tip to the southern tip of the continent. He writes in the preface that "our itinerary and plans took shape. From Tunis to Tripoli we would go on through the Libyan desert to the highlands of Tibesti. From there across wide tracts of desert to Lake Chad, and southward again through French Equatorial Africa to the huge rain forest of the Belgian Congo. Then, after thousands of miles in the interior, we would reach the east coast and a completely different world along the shore of the Indian Ocean. On through Tanganyika and the Rhodesias to South Africa . . . the big city of Johannesburg . . . to a fitting close at the Cape of Good Hope."

The book's first illustration is of Roman ruins at Sabratha, near Tripoli, and the last is made looking south from the southernmost crag of the Cape of Good Hope—the end of Africa. In between are pictures (in color or in black-and-white) of desert and forest, velds and sand dunes, primitive Negro villages and modern production plants, and an endless variety of life.

New Books

Adventurous Alliance. The story of the Agassiz family of Boston. Louise Hall Tharpe. Little, Brown, Boston, 1959. 367 pp. $5.

American Research on Russia. Harold H. Fisher, Ed. Indiana Univ. Press, Bloomington, 1959. 254 pp. $5.

The Armchair Science Reader. Isabel S. Gordon and Sophie Sorkin, Eds. Simon

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Reports

Ratio of Cesium-137 and Strontium-90 Radioactivity in Soil

Abstract. The similarity in genesis and the more pertinent physical characteristics of fission-produced Cs^{137} and Sr^{90} suggests the use of the first as a convenient monitor for the other prior to uptake in the biosphere. Results are presented which indicate the feasibility of this approach in the case of soils.

As repeatedly pointed out by Anderson (*1*), the desirability of using Cs^{137} as a monitor for Sr^{90} is predicated on the fact that the gamma rays emitted by Cs^{137}, because of their penetrability and discrete energy, can be quantitated with comparative ease from bulk samples of low specific activity without recourse to the more time-consuming and costlier chemical processes required for the measurement of the β-emitter Sr^{90} (*2*). This consideration is most apparent in the analysis of soils, where the technical requirements of accurate Sr^{90} measurements are most stringent.

During the fission process, approximately 1.76 atoms of Cs^{137} are formed for each atom of Sr^{90} (*3*); this leads to a Cs^{137}/Sr^{90} activity ratio of 1.83 (*4*). This ratio should be universally prevalent in fallout if no fractionation occurs from the time of detonation to the time of deposition on the ground. Published data show no glaring departures from this value in several media of fallout transport. Thus, sampling of the surface air by the U.S. Naval Research Laboratory in 1957 at 12 locations throughout the world indicated an over-all value of 2.10 ± 0.31 (*5*). The data of Stewart *et al.* (*6*) on rain water collected from January 1956 through June 1958 from 16 sites around the world show an average value of 1.54 ± 0.22 for the ratio of total Cs^{137}/total Sr^{90} activity present therein; they also imply that, owing to sampling difficulties, the true ratios are somewhat higher.

If, as visualized in all mechanisms of fallout transport, rain is the primary means of conveyance from the atmosphere to the ground, then the activity ratio in soil should closely approximate that found in rain water except in cases of severe differential leaching. In order to verify the correctness of this hypothesis it was thought advisable to measure directly the Cs^{137} and Sr^{90} content of soil. To this end, nine samples (*7*) analyzed for Sr^{90} by chemical means (*2*) at the Health and Safety Laboratory of the U.S. Atomic Energy Commission (*8*) were analyzed for Cs^{137} by scintillation spectrometry (*9*) at Argonne National Laboratory (*10*). The results are shown in Table 1. They supersede preliminary ratios for some of these soils where activity arising from the unsuspected presence of Mn^{54} was erroneously attributed to Cs^{137} (*11*).

The average value of the activity ratio for all nine samples is 1.62 ± 0.34, a value in good agreement with that of Stewart *et al.* (*6*). It should be noted that the ratio is not constant with depth at any given location and that further variation is introduced in going from one soil type to another. The differences in values are not within experimental error and presumably reflect differences in the ion-exchange properties of the soils in question (*12*). Comparison of total Cs^{137} with total Sr^{90} activity in soil tends to smooth out these variations. This was done by assuming that all fission activity was present in the top 6 inches of soil having a constant density, adding the observed concentrations in the proper proportions, and then determining the ratio. The results for the three soils for which sampling was done in two layers and for the two soils sampled to a depth of 6 inches are shown in the last column of the table. Both average values are in accord with the observations of rain water and with the theoretical value. An interesting comparison between ratios for rain water and soils at the same location may be made at Ottawa, Canada, where the total activity ratio in rain water from June 1956 to June 1958 was 1.32 (*6*) and the average soil value for 1957–58 was 1.44 ± 0.06. Taken at face value, this agreement between two decidedly low values suggests that the activity ratios may well vary in rain water and hence in soils, in various parts of the world, but that if this is so, the variation cannot be very large.

Since cesium and strontium behave chemically much like potassium and calcium, respectively, they are expected to be metabolically active in both plants and animals. Hence the activity ratio under such circumstances will depend not so much on the soil ratio as on the metabolic and ecological characteristics of the living specimen or product involved. However, if these factors remain constant, once the activity ratio has been established empirically for a

Table 1. Concentration of Cs^{137} and Sr^{90} in soil.

Sample No.*	Depth (in.)	Date collected	Cs^{137} ($\mu\mu c$/kg)	Sr^{90} ($\mu\mu c$/kg)	Cs^{137}/Sr^{90}	
					Individual sample	Top 6 in.
			Ithaca, New York			
56114	0–2	10–56	188 ± 12	101 ± 4.5	1.86 ± 0.20†	
57813	0–2	10–57	377 ± 44	167 ± 4.5	2.26 ± 0.33	1.87 ± 0.27†
57814	2–6	10–57	25.7 ± 0.8	31.1 ± 2.2	0.83 ± 0.09	
			Ottawa, Canada			
57276	0–6	4–57	63.2 ± 9.3	45.9 ± 2.3	1.38 ± 0.27	1.38 ± 0.27
58270	0–6	1958	81.1 ± 4.3	54.5 ± 2.2	1.49 ± 0.15	1.49 ± 0.15
			Kawailoa, Hawaii			
57996	0–2	12–57	411 ± 23	219 ± 7.7	1.88 ± 0.17	1.82 ± 0.20
57997	2–6	12–57	35.9 ± 3.5	23.2 ± 2.3	1.55 ± 0.32	
			Leilehua, Hawaii			
57998	0–2	12–57	226 ± 5	171 ± 1	1.32 ± 0.04	1.48 ± 0.08
57999	2–6	12–57	48.7 ± 3.9	23.9 ± 1.3	2.04 ± 0.28	
	Averages				1.62 ± 0.34‡	1.61 ± 0.19‡

* Beltsville numbers, according to the U.S. Department of Agriculture numbering system. † Deviation due to counting statistics. ‡ Average deviation from the mean.

Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should *not* repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper.

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to *one* 2-column figure (that is, a figure whose width equals two columns of text) or to *one* 2-column table or to *two* 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to Contributors" [*Science* **125**, 16 (1957)].

specified crop or animal product grown in a given locality for a representative length of time, subsequent measurements of Cs^{137} should be sufficient to monitor the Sr^{90} concentration as a function of time. This may be illustrated in the case of the U.S. Public Health Service measurements on the Cs^{137} and Sr^{90} content of milk (*13*). The results for 1958 show that the average monthly Cs^{137}/Sr^{90} activity ratio for 10 sampling stations in the United States varied from as low a value as 6.28 ± 1.28 to as much as 15.45 ± 5.62, with an average value of 10.09 ± 2.27; however, the variation about the mean found at any one station does not exceed ± 40 percent (Salt Lake City), and average variation per station is ± 27 percent for a 6- to 12-month period.

According to the findings in soil, it seems likely that the Sr^{90} concentration in this medium can be determined to within an error of 20 percent by measuring the Cs^{137} content and dividing by 1.6. The need for extending these observations to soils from other localities is obvious. Furthermore, if errors of 20 to 40 percent are tolerable in the estimates of Sr^{90}, relatively inexpensive surveys of wide coverage could be undertaken by monitoring Cs^{137} not only in soil but also in a great variety of material of ecological importance.

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24 June 1959

Electrical Output of a Receptor Membrane

Abstract. The electrical output of the receptor membrane of the nonmyelinated ending of Pacinian corpuscles is a function of the electrical gradients across the receptor membrane. The generator potential of the receptor membrane in response to equal mechanical stimuli varies linearly with the intensity of polarizing currents passed through the membrane. The production of a generator potential leaves a refractory state in the receptor membrane which is independent of the amount of charge transferred across the membrane but is dependent on a factor related to the strength of the stimulus which produced the response.

The receptor membrane of the nonmyelinated nerve ending of Pacinian corpuscles has the peculiarity that small regions of it can be excited independently. When a mechanical stimulus is applied to a small portion of nerve ending, the resulting electric response is confined to that region which has been stimulated mechanically and is not propagated to nonstimulated regions of the same receptor membrane by local circuit excitation (*1-3*). The generator potential of the entire receptor membrane appears to be built up by spatial summation of the electric activity of small independently excitable membrane regions (*generator elements*) (*2*).

For analytical purposes, the output of each generator element may be considered all-or-nothing with respect to the strength of the mechanical stimulus. The entire input-output relation of the receptor membrane—namely, the finely graded relation between stimulus strength and generator potential amplitude—may then be accounted for by spatial summation of the activity of such generator elements (*2*). The experiments described in the present report reveal that, although the electrical output at each generator element may be all-or-nothing with respect to the strength of the mechanical stimulus, it is graded with respect to the electrical gradients across the generator element.

The membrane potential of the receptor membrane was changed by passing inward or outward currents through the nonmyelinated nerve ending, while generator potentials were produced in this membrane by mechanical stimulation with a piezoelectric crystal stimulator. The capsules of single isolated Pacinian corpuscles were removed by microdissection. Each such preparation, consisting mainly of a nonmyelinated ending, has already been shown to have essentially the same mechanoreceptor properties as it has in the intact corpuscle (*4*). The decapsulated preparation offered a relatively naked nonmyelinated ending onto which polarizing currents were directly applied, and from which mechanically elicited generator potentials were directly led off with nonpolarizable electrodes, as is shown in Fig. 1.

When steady inward or outward currents are passed through the receptor membrane, the amplitude of the generator potential in response to a mechanical stimulus of constant strength varies as a linear function of the polarizing current (Fig. 2). The rate of rise of the generator potential is also a func-

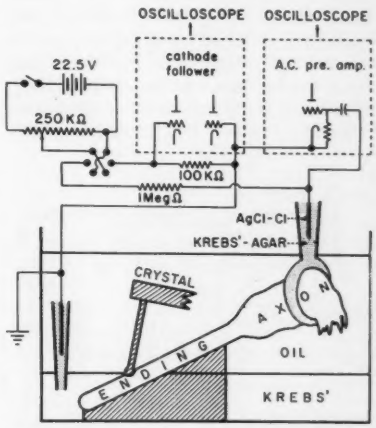

Fig. 1. Set-up for mechanical stimulation, polarization, and recording of the receptor membrane.

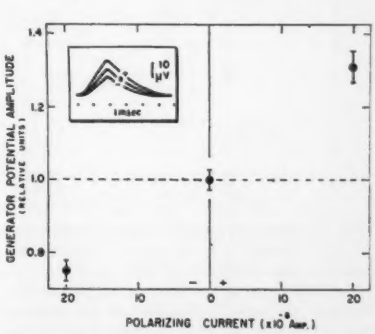

Fig. 2. Amplitude of mechanically elicited generator potential as a function of polarizing current. The mean amplitude of generator potential in response to equal mechanical stimuli is determined for various intensities of current flowing inward (hyperpolarizing, +) or outward (depolarizing, —) across the receptor membrane. The vertical bars subtend the standard error of the mean of approximately 30 generator potentials in each case. At any chosen current intensity, the polarizing current was on for at least 30 seconds before the start of each series of generator potential determinations. This allowed stable measurements. The inset shows three individual generator potentials (one of each series) whose mean amplitude is plotted in the main figure.

tion of the polarizing current. An analysis of these results, given elsewhere (*5*), suggests the following possibility: The mechanical stimulus causes the membrane potential across each generator element to drop to a certain fraction of the resting potential. This is equivalent to assuming that the transmembrane resistance across each generator element is shunted by a fixed leak resistor, when excited. This might occur, for example, if the activated generator element became permeable to all kinds of ions, as has been postulated for the end plate membrane of skeletal musculature (*6*). An increase in resting potential obtained by polarizing the receptor membrane with an inward current would then cause a proportionally increased fractional drop of membrane potential. Hence the generator potential, which is the aggregate result of all excited generator elements, should be directly proportional to the resting potential (*2*) (and to the polarizing current). It is of interest that the generator potential of a visual receptor has also been reported to increase as a function of the resting membrane potential (*7*).

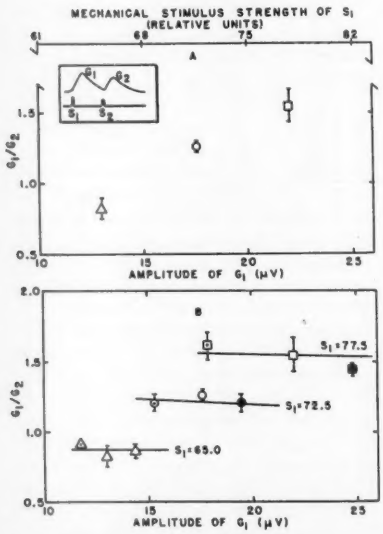

Fig. 3. Refractoriness of the receptor membrane unrelated to charge transfer. Two mechanical stimuli (S_1 and S_2) are successively applied so that the generator potential (G_2) in response to the second stimulus falls on the refractory trail of the generator potential (G_1) in response to the first. The ratio G_1/G_2 is determined while the amplitude of G_1—that is, the total amount of charge transferred—is varied in *A* by varying the stimulus strength (S_1) at constant resting membrane potential, and in *B*, by varying the resting potential across the receptor membrane at constant stimulus strength. (G_1 in response to three steps of stimulus strength was varied in *B* over a range of generator potential by polarizing currents.) Values of S_1 are displacements of the crystal stimulator given in relative units. S_2 was constant throughout all experiments. The vertical bars subtend a standard error of mean of approximately 30 generator potentials in each case. Curves in *B* were drawn by the method of least squaring.

It has previously been shown that excitation of a small region of the receptor membrane leaves a refractory condition behind so that a subsequent application of a mechanical stimulus to the same region elicits a response that is considerably smaller than normal. The refractory state, like the excited state, is confined to the mechanically stimulated region but does not spread to adjacent regions (*1*, *2*). If a generator potential is produced by applying a mechanical (conditioning) stimulus to a relatively large area of receptor membrane—that is, to an area containing a relatively large number of generator elements—a subsequent equal (test) stimulus, falling on the refractory trail of the first, elicits a generator potential of an amplitude inversely related to that of the conditioning generator potential (*8*, *9*). The measure of this effect has been called the "size factor of refractoriness" (*10*).

Since the amplitude of the generator potential increases as a function of the number of excited generator elements (*2*), and as a function of the electrical gradients across each excited generator element as well, the question arises whether it is the amount of charge transferred in response to the conditioning stimulus or the number of generator elements excited by the conditioning stimulus which determines the size factor of refractoriness. The present set-up gave us the opportunity to explore this question. The conditioning generator potential could be varied either by (i) changing the strength of the stimulus or by (ii) polarizing the receptor membrane at constant stimulus strength. By the first procedure, the number of conditioning-excited generator elements is varied at constant resting membrane potential of generator elements; by the second, the membrane potential of a given excited population of generator elements is varied. The results are shown in Fig. 3. It is seen that with procedure (i) the size factor—namely, the ratio of conditioning (G_1) to test generator potential (G_2)—increases progressively with the amplitude of conditioning generator potential (Fig. 3*A*), while this ratio remains approximately constant with procedure (ii) (Fig. 3*B*). It is clear from this result that the size factor of refractoriness does not depend on the amount of charge transferred but on another factor related to the strength of the stimulus.

The following explanation may be offered for this result: The conditioning stimulus excites a number of generator elements out of a statistically fluctuating population of excitable elements. Excitation of a generator element is followed by a refractory period. The first of these assertions has a good experimental basis (*9*, *11*); the second is an assumption. If, then, a test stimulus is applied during the refractory period, the number of nonrefractory generator elements available for excitation at the instant of application of the test stimulus may be expected to decrease with an increase in the number of generator elements excited by the conditioning stimulus. Hence the amplitude of test generator potential, which is a function of the number of excited generator elements (*2*), will expectedly decrease as a function of conditioning generator potential. A quantitative analysis of this question is given elsewhere (*5*) (*12*).

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Molecular Pumping

Abstract. A method is described for producing high vacua. A magnetically suspended molecular pumping rotor is operated inside a sealed glass vacuum system. The system is free of lubricants and can be baked out. The system gives promise of producing pressures below those previously used.

Gaede (*1*), Holweck (*2*), Siebahn (*3*), and others (*4*, *5*) have amply demonstrated the effectiveness of molecular pumping for producing vacua. In some of their experiments the lowest pressure obtained was limited only by the vapor

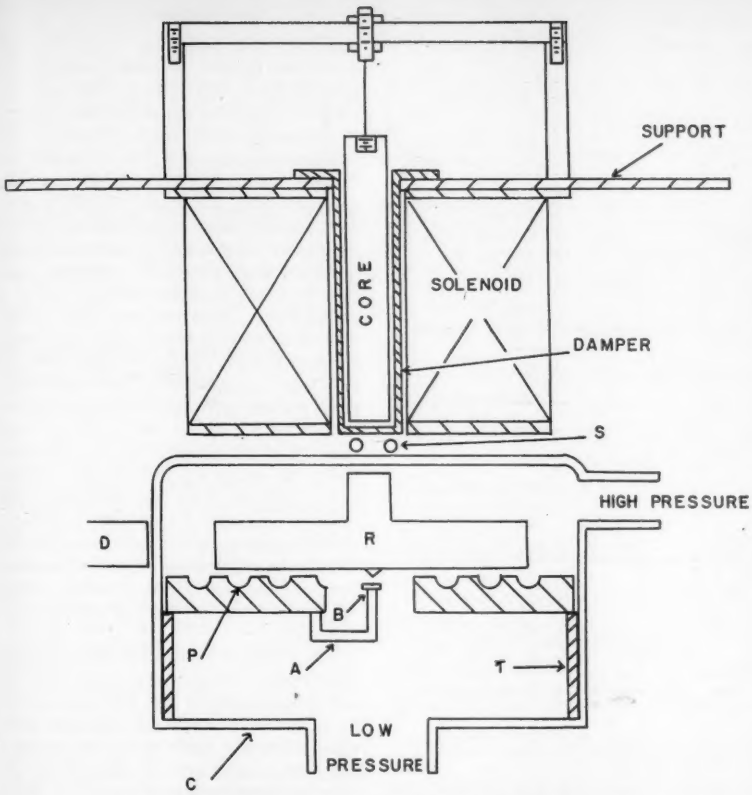

Fig. 1. Molecular pump with magnetically suspended rotor.

pressure of the lubricant in the bearings or by the fact that it was not possible to bake out the pumping system. For example, von Friesen (*4*) reported a pressure of 6.7×10^{-7} mm-Hg on the low-pressure side and 0.05 mm-Hg on the high-pressure side of his molecular pump. The pressure ratios usually vary from 10^2 to 10^6. According to theory (*6*), these pressure ratios should continue to hold at extremely low pressures.

In the course of some measurements of the gaseous friction on a magnetically suspended rotor spinning in a high vacuum, a considerable amount of molecular pumping was encountered. Since this pumping system can be baked out and is free of lubricated bearings, it appears worth while to indicate its possible use in producing very high vacua.

Figure 1 illustrates the principle of the method. The steel rotor *R* is freely suspended inside a vacuum-tight glass chamber *C* by the axial magnetic field of the solenoid, which is situated above the chamber. The sensing copper coil *S* is used to regulate the current through the solenoid in such a way as to maintain the rotor at the desired vertical position in the chamber. The rotor is spun by a rotating magnetic field produced by the drive coils *D*, located outside the glass chamber; that is, the rotor operates as the armature of an induction motor. A detailed description of the magnetic suspension and drive circuits has been published previously (*7*).

The pumping takes place between the spinning lower surface of the rotor *R* and the stationary upper surface of the plate *P*. Grooves are cut in the upper surface of *P* which spiral out from the axis to the periphery. The plate *P* is made of nonmagnetic low-vapor-pressure metal. The gas molecules are driven from the axis to the periphery by the spinning rotor. The clearance between the rotor and the plate *P* can be made 0.05 cm or less, while the depth of the grooves is of the order of 1 cm, the exact depth depending upon the pumping speed and the size of the rotor. The stainless-steel safety stop *B* is mounted on an arm *A* in such a way as not to obstruct the inlet to the pump. The plate *P* is supported on a closely fitting aluminum or copper foil washer which in turn is supported by a carefully ground glass telescoping tubing *T*. This permits the clearance that is necessary for differential expansion of *P* and *C* and at the same time provides a seal between the lower and upper chambers. With the solenoid removed, the entire system may be baked out for as long as necessary.

The peripheral speed is determined by the strength of the rotor but can easily be made twice the average molecular speed. The diameter of the rotor can be varied over as large a range as desired. If by means of modern pumping procedures the region around the periphery of the rotor is evacuated to a pressure of 10^{-9} or 10^{-10} mm-Hg, then a pumping ratio of 10^4 would give a pressure of 10^{-13} to 10^{-14} mm-Hg near the axis. If two or more such pumps were operated in series or in parallel and the glass chamber *C* were surrounded by an evacuated glass envelope, the pressure probably could be much further reduced. Another important factor is that the pumping speed can be made quite high. Also, the pump may be refrigerated—say, by liquid nitrogen—after the bake-out process and while it is in operation. This should greatly increase the effectiveness of the pump. With appropriate changes in the drive system, stainless-steel or other nonmagnetic vacuum chambers may be used instead of glass (*8*).

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Effect of Ultraviolet Pretreatment on Yield of Mutations by X-rays in Wheat

Abstract. A decrease in the yield of chromosomal aberrations in root meristems of wheat induced by four different doses of x-rays has been found to occur when the seeds are pretreated with ultraviolet radiation. However, in X_2 generation, the mutation rate for combined treatment is lower than for x-rays alone in lower dosages and higher than for x-rays alone in higher dosages.

Pre- or post-treatments combining such radiations as ultraviolet light or infrared with ionizing types have not been tested for their effects on mutation in higher plants. Swanson (*1*) has demonstrated that pre- or post-treatment with ultraviolet light will reduce the amount of chromosomal damage induced by x-rays in *Tradescantia*. In *Aspergillus*, combined ultraviolet and x-ray doses induced more mutations

Table 1. Frequency of occurrence of chromosome aberrations in x-ray and ultraviolet plus x-ray treatments.

X-ray dose (r)	Direct treatment		Ultraviolet pretreatment	
	No. of cells examined	Mean No. of aberrations ± S.E.*	No. of cells examined	Mean No. of aberrations ± S.E.*
11,000	218	1.11 ± 0.21	285	0.70 ± 0.13
16,000	139	1.68 ± 0.31	187	0.92 ± 0.25
22,000	146	2.90 ± 0.39	133	1.53 ± 0.24
33,000	109	3.67 ± 0.46	200	1.76 ± 0.38

*Standard error.

Table 2. Frequency of mutations after x-ray treatment and ultraviolet plus x-ray treatment.

Dose (r)	No. of families	No. of plants examined	Number of mutants of type								Mutation	
			Chloro-phyll	Short straw	Fine straw	Spel-toid	Dense ear	Lax ear	Awn char-acters	Others*	Total No.	Rate per X_1 plant progeny (%)
Control												
	99	2350	0	0	0	0	0	0	0	0	0	0
Ultraviolet alone												
	98	4900	0	0	0	0	0	0	0	0	0	0
X-rays alone												
11,000	60	7281	0	4	8	8	4	2	1	2	29	48.3
16,000	43	5093	0	3	4	6	4	1	4	6	28	65.1
22,000	27	3750	0	1	1	4	0	0	2	12	20	74.1
33,000	29	3967	0	0	0	8	4	0	1	2	15	51.7
Ultraviolet plus x-rays												
11,000	66	8250	0	1	4	2	2	1	1	3	14	21.2
16,000	64	8060	3	6	0	6	2	2	3	2	24	37.5
22,000	51	6750	0	4	0	7	6	4	5	15	41	80.4
33,000	47	5200	0	4	0	14	4	5	7	12	46	97.8

*These include grass clumps (early and late types) and mutations in the color and hairiness of glumes and in grain color.

than the sum for the two radiation treatments applied separately (see the review by Muller, *2*). We have carried out a similar experiment in bread wheat (*Triticum aestivum* L., $2n = 42$), and the results are summarized in this report.

Seeds of C.591, a highly stable and homogeneous variety of bread wheat characterized by a fully bearded earhead, white and pubescent glumes, amber-colored grains, and medium maturity, were subjected to the following treatments: (i) ultraviolet light for 1 hour; (ii) 11,000, 16,000, 22,000, and 33,000 r of x-rays; and (iii) pretreatment with ultraviolet for 1 hour followed by irradiation with 11,000, 16,000, 22,000, and 33,000 r of x-rays. A germicidal mercury-vapor tube which had an active radiation chiefly at wavelength 2537 A was used for ultraviolet treatment. Together with the control, there were thus ten lots of seeds, with 100 seeds per treatment.

These seeds were germinated, and cytological studies were carried out at metaphase in root-tip smears prepared from material fixed 24, 48, and 72 hours, respectively, after germination. Single and two-hit aberrations were scored separately but were pooled (due weight being given to two hit-aberrations and so on) for calculating the mean number of chromosome aberrations per cell (Table 1). Ultraviolet treatment alone did not induce any chromosome breakage; some degree of chromosome stickiness was the only discernible effect. The X_1 plants were grown during 1956, and the seeds from all plants which survived and flowered were harvested and stored separately. The X_2 progenies were raised in 1957, and the population was carefully scored for all phenotypically detectable mutations. Mutation frequency, expressed as a percentage of mutations per X_1 plant progeny, was calculated for all the treatments (Table 2). No spontaneous mutation was observed in the large amount of control material of this variety grown each year, and no mutations occurred in seeds irradiated with ultraviolet alone.

From the data in Table 2, it is seen that ultraviolet pretreatment caused, in comparison with the effects of x-rays alone, a reduction in the mutation rate at 11,000 and 16,000 r and an increase in the mutation rate at 22,000 and 33,000 r. The cytological data (Table 1) showed a significant reduction in the frequency of chromosome aberrations at all x-ray dosages following ultraviolet treatment. Since a majority of the induced mutations in bread wheat appear to be chromosomal in origin (*3*), the effect of ultraviolet in causing a reduction in the extent of chromosomal aberrations induced by x-rays by promoting restitution may be responsible for the decreased mutation rate observed in the combined ultraviolet and x-ray treatments at 11,000 and 16,000 r. The same consequence of ultraviolet pretreatment may account for the increase in mutation rate observed for 22,000 and 33,000 r, since in plants treated with 22,000 and 33,000 r of x-rays alone a large proportion of mutant gametes apparently carry several chromosome structural changes and are, as a result, either inviable or at a competitive disadvantage. This inference is supported by the fact that while X_1 plants from 22,000- and 33,000-r x-ray treatments showed 15- to 20-percent pollen sterility, the sterility was only 4 to 6 percent at the same x-ray dosages in plants pretreated with ultraviolet. A study of the possible synergism between ionizing radiations and other mutagenic agents such as ultraviolet in higher plants may have, therefore, to be carried out at various dosage combinations for a clear understanding of the nature of the interaction involved.

The types of mutations observed and their relative proportions were more or less similar in all the treatments; the X_2 progeny from plants treated with ultraviolet plus 16,000 r of x-rays, however, differed from the others in showing albina mutations. Albinas have not so far been recorded in mutation experiments in bread wheat (*3*, *4*). None of the 21 nullisomics in this species show chlorophyll deficiency (*5*). Furthermore, Sears (*6*) has shown that the dominant allele of Neatby's virescent gene *v*, located in chromosome III, is a member of a triplicate series concerned with chlorophyll development, the other two genes being situated on chromosomes XII and XVI, which are homoeologous with chromosome III. The high phenotypic stability of the chlorophyll apparatus in mutation experiments in bread wheat thus seems to be due to the presence of several unlinked factors controlling this character. Study of the root-tip chromosomes of an albina seedling from a parent plant treated with ultraviolet plus 16,000 r of x-rays showed that the mutant had the normal somatic chromosome number, $2n = 42$. A comparative study of the karyotypes of albina and control C.591 plants did not reveal any detectable difference. Thus, ultraviolet pretreatment appears to induce in some way the factors controlling chlorophyll development to mutate, although these factors remain unaffected by even high doses of x-rays (*7*).

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Carbon Dioxide Fixation in Marine Invertebrates: A Survey of Major Phyla

Abstract. Fourteen species of marine invertebrates representing 12 phyla were kept in sea water containing $NaHC^{14}O_3$ for 1 hour. All of them fixed CO_2 into acids of the Krebs citric acid cycle. In most species the major portion of the radioactivity recovered after chromatography was in succinic, fumaric, and malic acids. The findings favor the hypothesis that both CO_2 fixation and the citric acid cycle are virtually universal among marine invertebrates.

The finding of the reaction of CO_2 with propionate to form succinate in isolated tissue of the oyster (*1*) is one of the few demonstrations of CO_2 fixation in invertebrates. The only other marine invertebrate which has been investigated is the developing sea-urchin egg, which incorporates $C^{14}O_2$ into several fractions of organic material (*2*). In order to determine the extent of CO_2 fixation among marine invertebrates, animals representing 12 phyla were examined in this study (*3*).

The animals used in the experiments reported here were collected in the vicinity of Beaufort, North Carolina, during the summer months, and were used immediately after collection (*4*). After cleaning and weighing, whole animals or pieces of tissue were incubated in stoppered 125-ml flasks with filtered sea water to cover them. From 5 to 120 μc of $NaHC^{14}O_3$ were added from a syringe, giving concentrations in the medium of 0.5 to 5.3 μc/ml in all except the sponge. Details of each experiment are recorded in Table 1. Metabolic activity was halted after 60 minutes of incubation by placing the living material in cold acetone, and homogenization was begun at once. Organic acids were extracted according to the method of Frohman, Orten, and Smith (*5*), chromatographed with known acids on paper, and counted as described previously (*1*). The relative map positions of the acids agreed quite well with those reported by Carles *et al.* (*6*) for similar solvent systems.

The results of 14 experiments are

Table 1. Conditions of experiments on uptake of $NaHC^{14}O_3$ by marine invertebrates. Incubation time was 60 minutes in each case.

Species	No. of specimens	Fresh wt. (gm)	Volume of sea water (ml)	$NaHC^{14}O_3$ (μc)	Temp. (°C)
Hymeniacidon heliophila (sun sponge, Porifera)	Several branches	1.50	8.5	120	23.5
Aiptasia pallida (anemone, Cnidaria)	40	9.0	5.2	20	28.0
Bdelloura candida	150	0.53	6.0	32	28.0
Stylochus zebra (flatworms, Platyhelminthes)	1	0.07	1.0	5	28.5
Cerebratulus lacteus (ribbon worm, Nemertea)	1	0.74	10.0	25	27.2
Chaetopterus variopedatus (tube worm, Annelida)	1	19.0	10.5	50	30.5
Callinectes sapidus (blue crab, Arthropoda)	Digestive gland: 1	3.34	6.0	32	27.2
Limulus polyphemus (horseshoe crab, Arthropoda)	Digestive gland: 1	44.0	20.0	50	27.6
Crassostrea virginica (oyster, Mollusca)	Mantle tissue: 22	20.0	100.0	120	28.0
Bugula neritina (bryozoan, Ectoprocta)	Many colonies	50.0	100.0	50	24.0
Lingula unguis (lampshell, Brachiopoda)	Soft parts: 6	3.84	9.5	25	24.5
Leptosynapta inhaerens (sea cucumber, Echinodermata)	25	13.0	6.0	32	27.0
Saccoglossus kowalevskii (acorn worm, Hemichordata)	Pieces: 6	2.01	6.0	32	26.0
Styela plicata (tunicate, Chordata)	6	24.0	24.5	25	28.0

Table 2. Percentage of radioactivity in organic acids after exposure of animals to $NaHC^{14}O_3$.

Species	Count/min*	Acids†								Total recovery
		Suc	Fum	Mal	Cit	Iso	αKg	Unkn	Lac	
Hymeniacidon heliophila	613	61.2	25.5	12.3	0		0		0	99.0
Aiptasia pallida	1101	52.0	3.4	10.1	7.1		3.5		0	76.1
Bdelloura candida	4275	4.0	0.8	10.4	0.2	0.4	0.3	65.5	1.1	82.7
Stylochus zebra	260	8.7	3.7	17.4	0.9	18.8	0	41.9	0.9	92.3
Cerebratulus lacteus	1123	79.7	0.5	27.4	0		0		0	107.6
Chaetopterus variopedatus	2305	60.8	9.3	12.6	0.7		1.2		9.6	94.2
Callinectes sapidus	1983	82.0	6.6	9.4	0.1		3.4		2.5	104.0
Limulus polyphemus	844	21.6	20.5	17.5	6.0		3.2	6.3	17.4	92.5
Crassostrea virginica	2633	99.0	0.7	1.4	0		0		0	101.1
Bugula neritina	658	53.5	8.0	2.0	0	0		0	0	63.5
Lingula unguis	1651	92.9	1.7	0.6	0	0	0		0.4	95.6
Leptosynapta inhaerens	1293	20.8	8.1	16.8	7.5	17.4	10.0	4.2	0.9	85.3
Saccoglossus kowalevskii	3399	66.0	4.8	12.2	0.4	0.4	0.3	5.0	1.5	90.6
Styela plicata	507	30.5	3.6	15.8	5.7	6.5	1.5	6.9	1.1	71.6

* Radioactivity of acetone extracts at origin of chromatograms. † Succinic, fumaric, malic, citric, isocitric, α-ketoglutaric, unknown, and lactic acids, respectively.

listed in Table 2. Twelve of the species examined proved to have the major portion of the radioactivity recovered in three acids: succinic, fumaric, and malic. The exceptions were the flatworms, which had most of the radioactivity in unidentified acids. In the sea cucumber the acids of the cycle were more uniformly labeled than in any of the other animals. Zeros in Table 2 indicate that no radioactivity was found, and blank spaces indicate that no assay was made. The total recovery is the sum of the percentages found in individual acids and was more than 63 percent in all cases. The lower recoveries were in experiments which presented difficulty in eliminating pigments from the acetone extracts. Nine species yielded labeled lactic acid in addition to acids of the Krebs cycle.

The results demonstrate that CO_2 fixation occurs in many invertebrate groups. Earlier studies had shown that representatives of five animal phyla—namely, protozoa, nematodes, insects, echinoderms, and vertebrates—fix CO_2 or have enzymes capable of fixation. This report establishes the occurrence of fixation in marine representatives of 12 phyla, including three among the five already known, making a total of 14 so far examined. There are, however, some 22 recognized phyla of animals, and a number of radically distinct subphyla and classes within some of them, so that in a taxonomic sense a large fraction of the animal kingdom has not yet been investigated.

The operation of the citric acid cycle in the tissues of numerous invertebrates has been inferred from the evidence of increases in oxygen consumption on supplying cycle intermediates and inhibition by specific inhibitors, and occasionally from demonstration of enzymatic activities intrinsic to the cycle. Some invertebrates for which such evidence has been presented include *Ascaridia galli* and three other species of parasitic nematodes (*7*), the rat tapeworm *Hymenolepis diminuta* (*8*), an oligochaete worm *Peloscolex velutinus* (*9*), and the snails *Australorbis glabratus* (*10*) and *Helix pomatia* (*11*). Rockstein (*12*) has reviewed demonstrations of Krebs cycle activity in a variety of insects, although the work of Chance and Sacktor (*13*) suggests that this pathway is not of primary importance in insect flight metabolism.

Marine invertebrates in which the Krebs cycle is presumed to be active, on the basis of respiratory stimulation, include eggs of *Echinus esculentus*, investigated by Cleland and Rothschild (*14*), and eggs of three other species of sea urchins in work reviewed by them. Similar demonstrations have been made with eggs of the oyster *Ostrea commercialis* (*15*) and mantle tissue of the oyster *Crassostrea virginica* (*16*). In some marine invertebrates, for example, the sponge *Microciona prolifera* (*17*) and the spiny lobster *Panulirus japonicus* (*18*), stimulation of oxygen uptake by the addition of cycle intermediates could not be demonstrated.

The presence of the acids themselves in tissues would also provide evidence in favor of the cycle, but they are rarely demonstrated because they are in general "present in animal tissues in minimal quantities, and do not accumulate to an appreciable extent," according to Fruton and Simmonds (*19*). In this study the finding of radioactivity can be taken as evidence of succinic, fumaric, and malic acids in tissues of all 14 species, and evidence of two or more other acids of the cycle in nine species. The large accumulation of radioactivity in succinic acid in most of the animals was also found in the oyster mantle, in which fixation is accomplished by the conversion of propionate to succinate. It is not at all unlikely that the same pathway could be shown in these species. If this conversion occurs, then endogenous propionic acid would be expected. Considerable quantities of propionic and acetic acids have been reported present in a marine tube worm, *Eudistylia vancouveri* (*20*). The experiments on the two flatworms suggest quite a different pathway of CO_2 fixation in this group, which will be the object of further study.

The quantitative significance of invertebrate CO_2 fixation in the carbon cycle of the sea remains to be assessed. If the process is as widespread among marine invertebrates in general as these results suggest, then the portion of their respiratory CO_2 which they withhold for synthetic purposes may be large enough to affect the supply available to the photosynthetic organisms upon which the productivity of the sea is based.

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Nuclear and Atomic Properties of High-Energy Lithium Beams

Although the technique of preparation and acceleration of lithium ions has been known for several decades, a group at Chicago first observed nuclear reactions initiated by such high-energy ions in 1956. Fast protons observed in the bombardment of Li^7 targets by 1.7-Mev Li^7 projectiles showed the formation of the previously undetected nucleus B^{13}. At kinetic energies of a few million electron volts, two characteristics of lithium-induced transformations, compared with those caused by the conventional projectiles H, D, and He^4, are the relatively high nuclear energy releases and the relatively large number of reactions possible for a given combination of projectile and target. Thus with only 2-Mev kinetic energy available, lithium bombardments have made possible the study of the ground states of B^{13}, C^{15}, and N^{17} and many of the excited states of these little-known nuclei. Since the masses of the two lithium isotopes and of the light nuclei in the targets are well known, measurements of the kinetic energies of the reaction products makes possible the determination of new nuclear masses.

Two of the reactions possible between Li^7 and Be^9 are

$$Be^9(Li^7, Li^8)Be^8;\ Q = 0.363 \text{ Mev}$$

and

$$Be^9(Li^7, p)C^{15};\ Q = 9.05 \text{ Mev}$$

They probably proceed by quite different mechanisms, the former through simple neutron transfer between moving nuclei, the latter by complete barrier penetration and rearrangement of the nucleons in the original projectile and target. The relative yields and angular distributions support this interpretation. Electric excitation of target nuclei, caused by lithium projectiles passing outside the range of nuclear forces, has been observed.

Higher kinetic energies could be attained if, instead of Li^+, Li^{++} or Li^{+++} were accelerated. Furthermore, if Li^- could be prepared, it could be accelerated up a positive gradient, stripped to Li^{+++}, and again accelerated down the same gradient. These possibilities, in addition to the purely scientific interest of such studies, have led to the measurement of the effective ionic charge of lithium beams between 10- and 450-kev kinetic energy as they pass through target gases. Li^- has been observed as a constituent of a lithium beam brought to charge equilibrium in various gases, and, for instance, at 40-kev kinetic energy in propane gas the fraction 3×10^{-4} is in the negative form. Li^{+++} begins to be detectable as an equilibrium charge constituent in helium at around 200 kev.

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Structure and Behavior of Blood Cells of Three Species of Tunicates

Phase-microscope studies have been made of the cells of the blood of three species of Bermuda tunicates, *Ascidia nigra*, *Clavelina picta*, and *Ecteinascidia turbinata*. The behavior, including the type of locomotion, the degree of change in shape, and the presence or absence of Brownian motion of crystals or other particles within the cell, has been observed. Each of these three species of tunicates has both colored and colorless types of blood cells. *Ascidia nigra* presents a bluish cell type, an orange cell type, and a green cell type, together with seven colorless cell types. *Ecteinascidia turbinata* has an orange cell type and a green cell type but no blue cell type. The colorless cells are almost entirely similar to those of *Ascidia nigra*. *Clavelina picta* presents green cells, orange cells, and occasional brown cells, the colorless types again resembling those of the other two species. Phase-microscope observation reveals some hitherto unsuspected details of structure in certain of the colorless cell types. On the vacuolated cells of *Ascidia nigra*, a peculiar type of appendage has been seen. Each cell generally shows two to four long, beaded, motile appendages which undergo a sinuous motion. Such appendages maintain their motion for many hours after removal of the blood from the body. They may break off from the parent cell and continue to show independent motion. Attention is called also to the rather constant presence of a small, solid inclusion within the vacuole of these cells. An important feature of the blood and tissue cells in tunicates is the presence in the tissues of counterparts of many of the types of blood cells, fixed cells which appear to be homologous with the cells of the blood. It is suggested that the large "bladder cells" in the tunic of *Ascidia nigra* may correspond actually to the vacuolate cells. The presence in these bladder cells of one or more solid inclusion bodies is described.

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Biochemical Studies of Virus-Induced Neoplastic Growth

Biochemical changes in virus-induced neoplastic growth have been studied in chorioallantoic membranes of embryonated eggs infected with Rous sarcoma virus. Infected and noninfected cells have been incubated in Ringer-HCO_3 medium with C^{14}-glucose present in varying concentrations. Under these conditions the incorporation of C^{14} into tissue glycogen, lactic acid, fatty acids, and CO_2 has been determined. The utilization of glucose by these cells over a 3-hour experimental period was linear. This has allowed utilization of standard enzyme kinetics to evaluate glucose utilization by infected and uninfected cells. Lineweaver-Bruk plots of these data show a remarkable degree of reproducibility for an unresolved enzyme system. Uninfected cells have a $V_{max.}$ of glucose utilization of 3.0 to 7.0 μmole of glucose per hour per gram of wet tissue. The apparent K_s for uninfected cells ranges from 0.8 to $0.9 \times 10^{-3}M$. Rous sarcoma cells (infected tissue) show a $V_{max.}$ of 23 to 25 μmole of glucose per hour per gram. The apparent K_s for these cells ranges from 4.0 to $5.1 \times 10^{-3}M$.

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Erythrocyte Automosaicism in Polycythemics Treated with Phosphorus-32

Erythrocyte automosaicism is a blood-group heterogeneity originating within a single individual. It may be caused by somatic mutation or phenocopy production in the erythropoietic tissue. By means of an isotope dilution method involving serial agglutination of Cr^{51}-labeled cells with unlabeled carrier cells, the minor A_2 and O cell populations in A_1 persons can be measured. They are normally rather stable, although some spontaneous fluctuations in A_2 have been seen.

In two polycythemic patients treated with P^{32}, these minor fractions were followed for evidence of radiation-induced somatic mutation. Both cases showed marked increases in A_2 and O cells within 2 weeks of P^{32} injection (4 mc). At 1 month the A_2 cells had increased tenfold and the O had about doubled. Within 2 months the A_2 populations had returned to below their original levels (about 2×10^{-3}) and in one patient the O population was also beginning to decline. The initial rise seems excessive for specific locus mutation, and the trend reverses within the life span of normal erythrocytes, suggesting that postirradiation loss of A_2 is in part coincidental to the formation of defective cells with subnormal life span. This might be explained on the basis of gross chromosomal losses in the nucleated erythrocyte progenitors, except that the A_2 increase is much greater than the O. Deletions of the locus should not have produced A_2 cells except in the unlikely eventuality that both cases are genotypically A_1A_2. We cannot yet explain this

unforeseen radiation effect which has, very likely, obscured any contribution via the anticipated mutational mechanism.

K. C. ATWOOD, DONALD MEGILL
University of Chicago

Effects of High and Low pH and of Gelating and Liquefying Agents on Antigenic Transformations in Paramecium aurelia

A new antigenic type (51U) appeared during the past year in a culture of the paramecin-sensitive stock 51 of *Paramecium aurelia* that was being grown in 0.75 percent Cerophyl medium inoculated with *Aerobacter aerogenes*, a medium which for 3 years had kept serotype 51N stable. In an effort to learn what environmental change might have brought this new type to expression, we have run a number of experiments to test the effect of *p*H on antigenic transformation. To minimize the action of the bacteria on the *p*H of the medium, the culture fluid has been diluted with a buffer solution in proportions varying from 9 parts of buffer and 1 part of culture fluid to 6 parts of buffer and 4 parts of culture fluid. When used in the 6:4 ratio, Sorensen's Na_2HPO_4-KH_2PO_4 buffer has held the *p*H of the inoculated medium fairly close to the initial *p*H's of 5.8 and 7.8 during 3 days of bacterial growth.

The averaged results of three experiments with this combination of buffer and medium show a transformation of two-thirds of the 51U animals after 4 days of growth in the medium of low *p*H to 51B, a serotype which characteristically appears at low temperatures, while in the medium of high *p*H they show 79 percent of the animals remaining 51U. The total average numbers of divisions that occurred in the two groups during the 4 days of the experiments were closely similar: 5.2 fissions in the medium of low *p*H, 4.8 in that of high *p*H. In more dilute medium the 51U animals transformed 100 percent in both groups of tests, but in every case there was more of the low-temperature serotype 51B in the mixtures of low *p*H and more of the higher temperature types 51A, 51D, and 51E in the mixtures of high *p*H. In agreement with these results is the fact that cultures of 51B have been kept 100 percent stable for 6 weeks of growth in the undiluted rich Cerophyl medium with *p*H adjusted with $Ca(OH)_2$ to 6.2, while 51U was kept 100 percent stable by feeding the same medium after the *p*H was raised to 7.5 to 8.0.

Now in progress is a group of experiments in which the anticoagulant-liquefying substance heparin is being tested. This leaves serotype 51B 100 percent stable, while it induces 51D and 51E to transform almost 100 percent to 51B. In the dilutions used, 51A has transformed in only very small percentages (2 to 6) to 51B, but it is possible that stronger concentrations will increase these. Alcohol, on the other hand, has been found to be similar to heat in its effects on the serotypes. It leaves 51A 100 percent stable, but causes 51B to transform largely, and 51D in smaller numbers, to 51A. It is planned to check these results with tests of other liquefying and gelating agents.

MARY L. AUSTIN
Wellesley College

Effects of Varying the Extent and Intensity of the Daily Exposure to Light on the Cycle of Mating Type Reversals in Paramecium multimicronucleatum

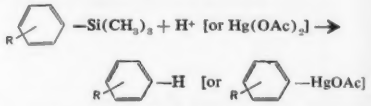
With daily cycles of light and darkness, each individual *Paramecium multimicronucleatum*, syngen 2, is known to be of mating type III during one part, and of mating type IV during another part, of each 24-hour period. With a constant light-dark cycle, the temporal relations between the light-dark changes and the mating-type changes differ in different natural stocks [T. M. Sonneborn, A. Barnett, *J. Protozool.* **5**, suppl., 18 (1958)]. Effects of varying the light-dark cycle were examined in certain clones of stock 19. When exposed daily to 4 hours of continuous illumination, the animals are mating type III except from about the 12th to about the 20th hour after the light goes on; during this period they are mating type IV. As the daily light phase is extended to 8, 12, 16, and 20 hours, the change from type III to type IV is progressively delayed about 2.4 hours for each 4-hour increment of the light phase (decrement of the dark phase), but the duration of the mating type IV phase, though variable (6 to 9.5 hours), is not regularly related to the duration of the light-dark periods. Transfer from any of these light regimes to continuous illumination results in progressive damping of the mating type cycle, the culture expressing type III at all hours after the 4th day. Similar damping occurs after transfer to continuous darkness, but continuous expression of one type did not occur in the period observed (8 days). With an 8-hour daily exposure to light, little if any effect of variations in light intensity within the range 25 to 1000 ft-ca was observed, except perhaps for slight increase in duration of the mating type IV phase with increasing light intensity. The relation of these results to other biological clock systems will be discussed.

This work was supported by a Public Health Service predoctoral fellowship of the National Cancer Institute and partially by a grant to T. M. Sonneborn, Indiana University, from the Atomic Energy Commission.

AUDREY BARNETT
Indiana University

Electrical Effects of Alkyl Substituents on an Aromatic Ring as Determined by Detrimethylsilylation

"Detrimethylsilylation" is a substitution reaction in which a trimethylsilyl group, $-Si(CH_3)_3$, is cleaved from an aromatic ring. These cleavages can be accomplished by reagents such as strong acids [proto-desilylation; *see* R. A. Benkeser and H. R. Krysiak, *J. Am. Chem. Soc.* **76**, 6353 (1954); C. Eaborn, *J. Chem. Soc.* **1956**, 4858 (1956); R. A. Benkeser, R. A. Hickner, D. I. Hoke, *J. Am. Chem. Soc.* **80**, 2279 (1958)] or mercuric acetate [mercuridesilylation; *see* R. A. Benkeser, D. I. Hoke, R. A. Hickner, *J. Am. Chem. Soc.* **80**, 5294 (1958)].



Both of these reactions are clean-cut and proceed at a rate which can be measured conveniently. Since synthetic methods are generally available which permit the attachment of a trimethylsilyl group to almost any position in an aromatic ring, detrimethylsilylation provides a valuable tool for determining the reactivity of a *particular* ring position toward electrophilic attack.

Recently, considerable interest has been generated in the electrical effects of alkyl groups substituted on a benzene ring [*see* series of papers on this topic in *Tetrahedron* **5**, 166 (1958); R. S. Milliken, *Tetrahedron* **6**, 68 (1959)]. While it is generally conceded that these groups possess a +I inductive effect which is in the order: *t*-butyl> *i*-propyl> ethyl> methyl, they also exhibit frequently a reverse order of influence which, in the past, was explained in terms of hyperconjugation (Baker-Nathan effect). It is the latter influence which has recently come under scrutiny [*see* series of papers in *Tetrahedron* **5**, 166 (1958)]. Detrimethylsilylation affords an excellent method of studying the electrical effects of alkyl groups, since the alkylated phenyltrimethylsilanes can be prepared and purified readily. In addition, they can be made to undergo facile cleavage by both acid [R. A. Benkeser, R. A. Hickner, D. I. Hoke, *J. Am. Chem. Soc.* **80**, 2279 (1958)] and mercuric acetate.

When the *m*-alkyltrimethylsilanes were submitted to both proto- and mercuride-

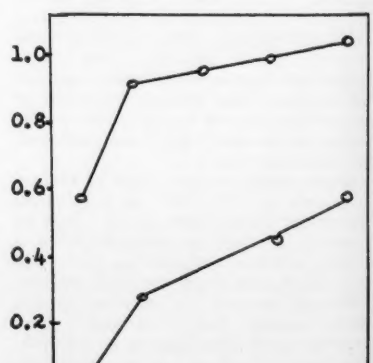


Fig. 1

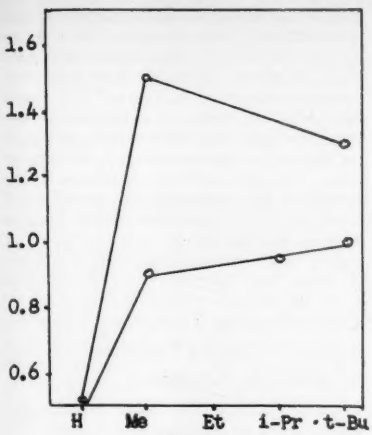


Fig. 2

silylation, a gradual increase in rate was noted as the *m*-alkyl substituent was varied systematically from methyl to *t*-butyl (Fig. 1). Obviously these rate trends can be explained quite satisfactorily in terms of the +I inductive effects of the *m*-alkyl groups. On the other hand, an unexpected conflict of trends was noted when the *p*-alkyltrimethylsilanes were cleaved with acid and mercuric acetate (Fig. 2). Thus, protodesilylation follows the Baker-Nathan sequence, while mercuridesilylation does not.

Since protodesilylation is carried out in a very polar medium (for example, mineral acids in aqueous acetic acid) and mercuridesilylation is not (mercuric acetate in glacial acetic acid), it can be concluded that, very likely, the Baker-Nathan sequence is associated, at least in part, with solvation effects [W. A. Sweeney and W. M. Schubert, *J. Am. Chem. Soc.* **76**, 4625 (1954); subsequent papers by Schubert; R. A. Clement and J. N. Naghizadeh, *J. Am. Chem. Soc.* **81**, 3154 (1959)].

ROBERT A. BENKESER
THOMAS V. LISTON
Purdue University

Hot Carrier Investigations in Semiconductors

Much of the current extensive information about semiconductors stems from the temperature-dependent studies of the electrical, magnetic, and optical properties. A promising new tool of investigation consists of the increase in the average energy of the charge carriers *alone*, while leaving the lattice temperature constant. Such "hot" carriers are produced by applying short (microsecond) pulses of high electric fields, during which the carriers initially gain energy from the field much faster than they can lose it to the lattice in collisions. After a few collisions, a steady state is attained, with the carriers having an increased "effective temperature." When the carrier mobility is high (10^4 to 10 cm^2/volt sec), carrier heating is already noticeable at a few volts per centimeter. While it has not yet been possible to measure directly the effective temperature of the hot carriers, the latter has been estimated from measurements of energy-dependent properties such as the carrier mobility. Hot carriers have been applied primarily for studying (i) scattering and energy loss mechanisms of carriers from mobility measurements, and (ii) ionization mechanisms of neutral impurities. With regard to the former, the increase in lattice scattering and the decrease in impurity scattering with increasing carrier energy have been demonstrated in germanium. Also the disappearance of magneto-resistance has been observed as the lattice mobility of the hot carriers is decreased. Ionization studies of zinc and copper impurities in germanium have shown that carrier heating is much less effective than lattice heating in ionization processes, leading to the conclusion that impurity ionization and recombination kinetics are dominated by carrier-phonon interactions.

RALPH BRAY
Purdue University

Balance between Coherence and Variation in Evolution

Why do living things exist as recognizable species instead of as confluent masses of variation? Recent experiments have disclosed that even ecological races within the same wild species are held together by moderate genetic coherences, and the segregations of their hybrids favor the parental combinations.

In ecological races each morphological and physiological character is regulated by a system of several genes distributed on several chromosomes. In their segregating hybrids, combinations of paired parental characters are usually correlated, indicating that at least two pairs of the regulating genes are located on a common pair of chromosomes, whereas other genes governing them may recombine freely. The racial characters are thus held together by direct and indirect bonds of various strength.

This kind of genetic structure provides both coherence and flexibility. It favors the retention of the existing races even at their points of contact as long as the differentiating environments remain essentially unchanged. Major changes in the environment, combined with interracial crossings, may favor certain crossover combinations if they are better adapted, and the existing linkage mechanism will accelerate the constancy of the favored recombinants. New variability is simultaneously released, because complementary and oppositional genes carried by separate races become activated through crossing, producing transgressive segregation.

Shifts in the environment tend to alter the balance between coherence and variation, promoting migration, natural crossings, release of potential variability and shifts in selective pressure. Such shifts change the biotype content of the races and of the species itself.

JENS CLAUSEN, WILLIAM M. HIESEY
Carnegie Institution of Washington

Metabolic Fate of Macronuclear DNA after Autogamy in Paramecium aurelia—an Autoradiographic Study

During the nuclear reorganization process of autogamy the macronucleus disintegrates into approximately 40 to 60 fragments. The ultimate fate of these fragments is assumed to be resorption into the cytoplasm. An attempt has been made to answer the question whether the nucleic acid of the macronuclear fragments is reutilized in the formation of the new macronucleus.

Paramecia were grown in a complex axenic medium containing 50 c of tritiated thymidine per milliliter. After 5 days of growth the cells were collected and washed free of excess thymidine with sterile isotonic salt solution. The labeled cells were then either (i) inoculated into fresh medium containing no tracer; (ii) inoculated into sterile exhausted medium containing no tracer; (iii) inoculated into sterile isotonic salt solution. After various time intervals cells were removed for autoradiographic analysis. The results show that there is no preferential incorporation of label into the newly developing macronucleus from the labeled fragments in either fresh or exhausted medium. Reutilization of labeled material under starvation conditions (salt medium) could not be definitely established. The new macronucleus formed in very "hot" autogamous cells was slightly labeled, indicating that small amounts of old macronuclear material are reutilized. The cytoplasm of cells grown in high concentrations of tritiated thymidine is also labeled. Experiments are in progress to determine whether this cytoplasmic labeling is associated with RNA.

JOHN BERECH, JR.
W. J. VAN WAGTENDONK
Indiana University

Hyperventilation and Shivering

Two methods were utilized for inducing increased ventilation in male human subjects clad only in shorts and exposed to ambient temperatures of 5° to 10°C (dry bulb) and 50 percent relative humidity. The first method consisted of having the subject breathe an air mixture containing 6 percent carbon dioxide for 10 to 30 minutes at selected times during the exposure to cold. In the second method the subjects hyperventilated voluntarily at rates simulating that induced by carbon dioxide (40 to 50 l/min). Carbon dioxide suppressed shivering for varying time periods, usually from 20 to 30 minutes. Voluntary hyperventilation increased shivering with an approximate twofold increase in oxygen consumption. Therefore, it can be concluded that the carbon dioxide suppression is a direct effect of shivering mechanisms and is not due to the increased muscular effort of extra ventilation. The time of onset of enhanced shivering with voluntary hyperventilation was not related to the establishment of the arterial pCO_2 at a new lowered level but was related to a certain quantity and rate

of extra heat loss from the respiratory tract. The quantity of heat loss was calculated from data on the changes in temperature and water vapor content in the respired air. Voluntary hyperventilation appears to be a useful tool in experiments on temperature regulation because a controlled rate of imposing a measurable body heat deficit can be established.

R. W. BULLARD, G. D. ANDERSON
Indiana University Medical School

Interconversion of Boranes

Study of the kinetics of reaction and isotope effects and isolation of intermediates in the decomposition of diborane and higher boranes leads to the mechanism

$$B_2H_6 \rightleftarrows 2BH_3 \quad (1)$$

$$B_2H_6 + BH_3 \rightleftarrows B_3H_9 \quad (2)$$

$$B_3H_9 \rightleftarrows B_3H_7 + H_2 \quad (3)$$

$$B_3H_7 + B_2H_6 \rightleftarrows B_4H_{10} + BH_3 \quad (4)$$

$$B_4H_{10} \rightleftarrows B_4H_8 + H_2 \quad (5)$$

$$B_4H_8 + B_2H_6 \rightleftarrows B_5H_{11} + BH_3 \quad (6)$$

where reactions 3 and 5 are relatively slow. The structural implications of the mechanism are considered.

GERALD BRENNAN, RICHARD ENRIONE, RILEY SCHAEFFER
Indiana University
JOHN DUPONT
Redstone Arsenal

Radial Velocities of 11th Magnitude A and K Stars

Spectra of more than 1200 11th magnitude A and K stars have been taken with the Cassegrain spectrograph on the 82-inch reflector at the McDonald Observatory. The observing program was completed in January 1959.

The A stars measured to date seem to be consistent with the standard solar motion of 20 km/sec and a galactic rotation effect rA = 15 km/sec. K stars of luminosity classes I and II are not sufficiently numerous in this material to yield any reliable general conclusions. A preliminary analysis of the K III stars yields a standard solar motion and rA = 17.5 km/sec. The K IV stars also give a solar motion only slightly larger than the standard value.

Space motions have been computed for the dwarfs (K V). The solar motion is about 5 km/sec less than the standard value. The velocity ellipsoid of the K dwarfs has axes ± 18, ± 21, and ± 30 km/sec. These are smaller than the values obtained from other material (for example, see Table 11, page 227, *Handbuch der Physik*, vol. 51). It should be emphasized that the stars in the present study have not been selected according to the size of the proper motion and hence are free from the statistical bias due to such selection.

FRANK K. EDMONDSON
Indiana University

Pharmacological Study of Digitalis-like Steroids

During the last 30 years we have studied pharmacologically almost 400 compounds for their possible digitalis-like action. A large number of them are cardenolides and their glycosides; a smaller number, bufadienolides and their glycosides; and others, simple synthetic lactones. Our work started with the isolation of active substances from the poison of 12 different species of toads. This was followed by the separation of thevetin from the nuts of *Thevetia neriifolia*. In recent years our active materials have been supplied by several steroid chemists, particularly T. Reichstein. The cat is the animal most susceptible to cardiotonic substances. Often sufficient qualitative and quantitative data can be obtained from samples of 3 to 5 mg prior to clinical testing, provided the substance is potent. Among the aglycones of corresponding structures, the bufadienolides are stronger than the cardenolides. The lactone ring is indispensable for the activity in both instances. The glycosides of the cardenolide series are invariably more potent than their aglycones. The activity of bufadienolides, on the other hand, is not increased when conjugation of sugar molecules takes place with the secondary hydroxy group at C_3. Acetylation of the hydroxy group at either C_{16} or C_3 enhances the cardiotonic potency. A change of the asymmetrical center at C_3, C_5, or C_{17} from the natural configuration usually results in a loss of activity. With the cooperation of Harry Gold, 37 glycosides or esters of aglycones were investigated in patients with auricular fibrillation. It is interesting that none of them is as completely absorbed through the gastrointestinal tract as digitoxin. Solubility in water cannot account for the differences.

K. K. CHEN
Lilly Research Laboratories

Incorporation of Adenine Nucleotide into Ribonucleic Acid

An enzyme system, isolated from the soluble, cytoplasmic fraction of embryonic tissue homogenates, appears to be concerned in the synthesis of ribonucleic acid (RNA), as shown by the following properties: it catalyzes the incorporation of labeled pyrophosphate into ribonucleoside triphosphates (reaction 1) and of the adenylate portion of labeled adenosinetriphosphate into RNA (reaction 2). Both reactions require the addition of exogenous RNA and of Mg^{++}, and in both the corresponding ribonucleoside diphosphates are inert, as is phosphate in reaction 1. Reaction 2 is stimulated two- to fivefold by the addition of cytidine triphosphate, uridine triphosphate, and guanosine triphosphate singly or in combination. Up to 85 percent of the incorporated adenylate is found in nonterminal positions under optimal conditions. These include: a *p*H between 9.0 and 9.5, the presence of Mn^{++} ($8.25 \times 10^{-4}M$) in addition to Mg^{++} ($1.25 \times 10^{-2}M$) and the addition of cadaverine or spermidine (approximately $4 \times 10^{-3}M$). The enzyme system is inhibited by a wide variety of anionic polymers, including DNA at relatively high concentrations (> 20 μg/ml of reaction mixture). At lower concentrations (between 3 and 10 μg/ml) DNA appears to stimulate the reaction. The significance of these findings and the possible role of this system in RNA synthesis will be discussed.

C. W. CHUNG, H. R. MAHLER
Indiana University

Genetic Load as a Means of Analysis of Hidden Variability in Drosophila Populations

When chromosomes from wild populations are made homozygous there is a substantial reduction in viability due to recessive or partially recessive deleterious factors normally carried in the population. Although chromosomes with mild effects grade imperceptibly into the normal class, their over-all effect can be assessed by measuring the homozygous "load"—the average proportional reduction in viability of homozygous chromosomes compared with randomly combined chromosomes from the same population. The average load was about 47 percent for second chromosomes from natural and caged populations of *Drosophila melanogaster*. Of this, a little more than half was due to lethal factors; the rest was due to the cumulative effect of individually milder factors, called here detrimentals. Since these populations should be near equilibrium, the results imply either (i) that detrimentals occur no more frequently than lethals, or (ii) that detrimentals have more dominance than lethals and hence are eliminated more rapidly as heterozygotes. A higher contribution from detrimentals might have been found in more crowded cultures.

Comparison of the ratio of the lethal load to the detrimental load with the same ratio for newly occurring mutants can give information on the comparative rate of elimination of lethals and detrimentals. The data are insufficient to distinguish between a faster elimination rate, and hence greater dominance for detrimentals, and the same average dominance for lethals and detrimentals. However, they offer no support for the idea that mildly detrimental genes are less dominant or that overdominant loci make a major contribution to the decline in fitness with inbreeding.

JAMES F. CROW
University of Wisconsin

Environmental Control of Gastrointestinal Activity

To study the effect of external conditions upon human gastrointestinal activity, a method of recording the activity from external electrodes has been used so as to avoid any possibly stimulating insertion into the tract. The variables of time after eating, rest, body position,

auditory and visual stimulation, problem solving, and avoiding a noxious stimulus have been studied. Recorded under resting conditions, gastrointestinal activity declines during the first 3 to 4 hours after a meal and remains at a low level until at least 15 hours after eating. The effect of rest itself is to produce a decline in gastrointestinal activity lasting ordinarily about 20 minutes. Activity when the person is standing is increased over that found when he is lying down. A strong auditory or visual stimulus produces a high-voltage slow wave in many people. This seems to be of gastric origin, but apparently does not represent a muscular contraction. With or without this wave an increase in activity is produced by such stimuli. This is not highly dependent on digestive state. Solution of arithmetic problems is accompanied by an increase in the motility of the empty stomach. An especially large increase in the activity of the empty stomach is produced by the task of pressing a key every 30 seconds (subject estimating the time) in order to avoid a noxious stimulus.

An important fraction of gastrointestinal activity seems to be under the control of environmental stimuli and conditions.

R. C. DAVIS

Indiana University

Distribution of DNA in Kappa Particles of Paramecium in Relation to the Problem of Their Bacterial Affinities

In the light microscope, kappa particles appear to possess diffusely and uniformly distributed DNA (Preer, 1950). The same is true for mu and pi particles. This feature has been stressed, as one of two which distinguish these particles from bacteria (Sonneborn, 1959). The difference is not due merely to the small size of the particles because (i) some bacteria of the same size show a distinct chromatinic body, and (ii) a much larger (4 by 1 μ) particle (lambda in killer stock 299) also shows uniformly diffuse DNA. Electron microscope examination of a wide range of particle types in diverse stocks (51, 138, 214, and 299) of *Paramecium aurelia* shows differences in structure among them, but all agree in possessing two main regions: areas of high electron density containing matrix and Palade-type granules; areas of very low electron density and irregular shape, sometimes containing filaments and dense granules. It is well known that bacteria show comparable regions, the areas of high density being cytoplasm, those of low density, chromatinic bodies. If the same were true for kappa particles, the apparently uniform distribution of DNA in light microscopy would follow from the irregular distribution of the low-density areas throughout the particles. The distribution of delimited DNA areas throughout the kappa particle appears to be comparable to dispersion of bacterial DNA under certain conditions (Chapman and Kroll, 1957; Whitfield and Murray, 1956). If this is a result of cytoplasmic conditions in the paramecia, a major difficulty in identifying these particles with bacteria would be removed.

This work was supported by grants to T. M. Sonneborn, Indiana University, from the American Cancer Society and the Atomic Energy Commission.

RUTH V. DIPPELL

Indiana University

Isolation and Properties of Nerve-Growth Promoting Protein from Mouse Salivary Gland and Its Neuro-Cytotoxic Antiserum

A protein which stimulates the growth of sensory and sympathetic nerve cells, both in tissue culture and in the living chick embryo, has recently been isolated from snake venom. This finding has led to an examination of the salivary glands of other species for biologically similar factors.

The submaxillary gland of the mouse has been found to be a very potent source of the growth factor. The biological activity is associated with a protein, which has been purified approximately 100-fold by standard procedures of protein fractionation. When examined in an analytical ultracentrifuge, only a single peak was detectable with an s_{20} of 4.3 Svedberg units. The evidence supporting the view that the salivary gland factor is a protein includes the following data: (i) the biological activity is destroyed upon incubation with proteolytic enzymes, and (ii) the factor is antigenic and the antiserum thus obtained inhibits its biological activity.

The injection of the growth factor into newborn mice results in a marked net increase in the protein, RNA, and DNA content of the superior cervical ganglion. Conversely, the injection of the antiserum into a variety of mammals results in atrophy and destruction of the sympathetic nerve cells.

STANLEY COHEN

Washington University

Preferential Pairing in Trisomic, Triploid and Tetraploid Inversion Heterozygotes of Zea mays

Genetic and cytological studies with trisomic, triploid and tetraploid maize plants which are heterozygous for a paracentric inversion including slightly more than half of the long arm of chromosome 3 (3L.4-.95) indicate that pairing is not at random among homologues which differ by this structural change. There is a great tendency for structurally identical chromosomes to pair preferentially with each other.

Preferential pairing was determined by the backcross ratios for the *a* locus which is included within the inversion. Preferential pairing has a marked effect on the *A*:*a* ratio in the progeny. If only bivalents are formed and pairing is preferential in tetraploids of *In A/ In A/ N a/ N a* constitution, all gametes will be *Aa* and there will be no homozygous recessive *a* individuals in the progeny. Quadrivalent formation accompanied by preferential orientation will give more *Aa* gametes than expected in control plants with identical homologues, if the frequency of genetic nondisjunction is less than 1/3. Data from several types of inversion 3 heterozygotes and the corresponding control plants indicate that pairing is not at random in polyploid heterozygotes.

Cytological evidence of preferential pairing comes from the comparison of chromatid bridge frequencies in tetraploids having a single inverted chromosome (simplex condition) with those possessing two inverted and two normal chromosomes 3 (duplex condition). Since a chromatid bridge is formed after crossing-over between a paired normal and inverted segment, it follows that the frequency of chromatid bridges is a function of the frequency of this type of association. The amount of preferential pairing can be derived from these data. If pairing were at random, the expected frequency of association between two structurally different chromosomes would be 66.6 percent. The data from cytological studies indicate that pairing of this type occurs only 24 percent of the time, whereas structurally identical homologues are associated 76 percent of the time.

Thus a relatively simple morphological change strongly affects the progress of synapsis in a tetraploid. This study is relevant to an understanding of the loss of homology and consequently pairing affinity in evolutionary divergence.

G. G. DOYLE

Indiana University

π^* Bonding in Metal Carbonyls and Derivatives

A qualitative molecular orbital model of the bonding in mononuclear metal carbonyls and derivatives has proved useful in understanding their vibrational spectra. The "lone-pair" σ, the π, and π^* orbitals of CO and the appropriate metal *d*, *s*, and *p* orbitals were used. The results for $M(CO)_4$, for example, show 12 "lower" energy or B orbitals; 9 are bonding between M and CO and 3 are nonbonding, π orbitals. When the relative energies of the π^* orbitals are so high that they make no contribution to the 5 remaining occupied or "A orbitals," the latter are antibonding between M and CO. The occurrence of π^* character in these orbitals results in a stabilization of this subshell, a reduction in M–CO antibonding character, and the appearance of C–O antibonding character. Thus, π^* stabilization of the A orbitals is a primary factor in the bonding description.

The model predicts a substantial increase in π^* stabilization with charge in a series such as $Ni(CO)_4$, $Co(CO)_4^-$, and $Fe(CO)_4^{--}$; a substantial drop was found in the C–O stretching frequencies in these and other ions. A C–O force constant drop of greater than 2.5 md/A occurs from $Ni(CO)_4$ to $Co(CO)_4^-$ and from $Fe(CO)_5$ to $Mn(CO)_5^-$ and of more than 4 md/A from $Ni(CO)_4$ to $Fe(CO)_4^{--}$.

A measure of the π^* stabilization in

$Ni(CO)_4$ relative to that in $Fe(CO)_4^{--}$ may be defined through

$$[k_{CO} - k_{Ni(CO)_4}]/[k_{CO} - k_{Fe(CO)_4^{--}}]$$

(where k is a C–O bond stretching force constant) whose preliminary value is 0.3. This indicates that the π^* stabilization in $Ni(CO)_4$ is only a modest fraction of the total possible. A similar description applies to the CO groups in metal carbonyl hydrides and nitrosyls, while the NO π^* character is definitely greater.

WALTER F. EDGELL

Purdue University

Mechanism of Excitation Transfer in Scintillator Solutions

The decay times of luminescence in scintillator solutions are known to be of the order of millimicroseconds. A repetitive time-selection technique for measurement of such decay times is described; the method derives from that of the older Becquerel (1861). The accuracy of the method now makes possible the resolution of decay times belonging to the solvent and to the scintillator processes respectively. Together with previous work on luminescence intensity, recent data on the decay times of scintillator solutions in benzene and other solvents are interpreted to indicate that the transfer of excitation from a primarily excited solvent molecule to a scintillator molecule occurs through the intermediary of intervening benzene molecules. A typical rate constant of the pertinent excitation-transfer when *p*-terphenyl is the solute is 9.3×10^{10} liter $mole^{-1}$ sec^{-1} within an accuracy of about 5 percent. An excitation transfer in which the intervening solvent molecules are not involved is inadequate to explain the totality of the effects.

MILTON BURTON

University of Notre Dame

Viability of Drosophila Heterozygous for Irradiated Chromosomes

It has been suggested in recent years, mainly as a consequence of studies made with artificial and natural populations, that heterozygosity might be different in principle from homozygosity and that it is usually associated with superior viability. A corollary of such a hypothesis would be that irradiation given to highly isogenic populations would be beneficial on the average rather than detrimental. Experiments made by Wallace seemed to confirm such conclusions.

A great number of lines was prepared from stocks made by H. J. Muller for these purposes so that they were originally homozygous and coisogenic for their second and their *ve*-marked third chromosomes, except for heterozygosity for the recessive marker *st* on their third chromosome. Half the lines had their *ve st*$^+$ chromosome irradiated with a dose of 24,000 r, given to the spermatogonia. By backcrossing these lines to a coisogenic stock, homozygous for *ve st*, for a number of generations, viability could be measured. Viability of control homozygous lines was compared with that of the lines having one irradiated chromosome superposed on the same otherwise homozygous background. Viability of heterozygotes having one irradiated chromosome on a largely heterozygous but uniform background was also measured.

Although many recessive lethal as well as detrimental mutations were induced, no increase in the average viability of the isogenic flies could be demonstrated as a result of the heterozygosity caused by the radiation-induced mutations.

This work was done while I was on a postdoctoral fellowship of U.S. Public Health Service, administered at Indiana University, and supported by U.S. Public Health Service grant RG5286(C1) to H. J. Muller and associates.

RAPHAEL FALK

Indiana University

Immunological Evidence for Variation of Mitochondria Isolated from Paramecium

Mitochondria and other particulates—cilia, trichocysts, and small granules—have been isolated from cells descended from a single *Paramecium aurelia*. The soluble antigens have been extracted and studied by gel diffusion techniques. As has been found with other organisms, some of the particles probably have several antigens in common as well as specific antigens only associated with certain fractions. There is some evidence for the presence of related but distinguishable antigens from morphologically and functionally different organelles.

Antisera prepared against whole cells and against particles, when diffused against mitochondria of a single clone, have disclosed differences (cross reactions) between antibodies, indicating differences between the antigens injected and those tested. Gel analyses and absorption experiments have lent support to the suggestion that variations exist in the antigenic composition of mitochondria in proliferating cells analogous to the antigenic transformation previously observed with immobilization antigens located in the cilia and pellicle. At least two such labile mitochondrial groups exist, each behaving as though they are separate molecules. These antigens show no immunological relationship to the immobilization antigens.

IRVING FINGER, PHILIP KITTNER, CAROL C. HELLER

Haverford College

Photosynthetic Conversion of Light Energy into Chemical Energy

This theory is based mainly upon the same physical observations which have been decisive for the successful interpretation of ordinary nonbiological photochemical reactions. The behavior of chlorophyll fluorescence in living plants has shown that the energy transfer from one light-excited pigment molecule to another by sensitized fluorescence is an exceedingly efficient process. This mechanism explains the migration of excitation energy from the bulk of the chlorophyll molecules to the few among them that are in permanent contact with water, the OH-accepting enzyme, and dissolved substances. On this basis, not only the role of the photosynthetic unit but also the afterglow of living chlorophyll as well as Emerson's important finding of a cooperation between two light-absorption acts become easily understandable.

Intensity measurements of the fluorescence in plant cells indicate that the final photosynthetic oxidants are not reduced indirectly via electrons or enzymes but in direct contact with the chlorophyll. During this process the first excited singlet and the metastable lowest triplet states contribute their energy equally often to the photochemical steps. We are forced to assume that the metastable state provides its energy for a preparatory step which consists in the transformation of both the chlorophyll and the oxidant from the keto into the enol form. This leads to a storage of about 20 kcal in a new complex. The second step, the simultaneous transfer of H to the oxidant and of OH to the enzyme makes use of the sum of the previously stored 20 kcal plus that of the 41 kcal delivered from a singlet excitation.

JAMES FRANCK

University of Chicago

Evolution of the Structure and Behavior of Termites with a Reexamination of the Concepts of Vestiges, Recapitulation, and Caenogenesis

Comparative study of the structure and behavior of the castes of different genera of termites indicates evolutionary advances and regressions of adaptive functions. Vestigial structures may be found in one caste that are homologous with functional structures in other castes with essentially identical genetics. In addition, nonfunctional vestigial structures are found that are homologous with functional characters in more primitive termites. In some instances, young stages of development (nymphs) exhibit vestigial structures that are nonfunctional in the early stage, are completely absent in the adult, but are functional only in the adult stage in more primitive genera.

The 19th century concepts of the evolution of vestiges, of recapitulation, of caenogenesis, of deuterogenesis, and of the social supraorganism are reexamined, and the attempt is made to bring the facts into harmony with modern principles of genetics, development, ecology, and systematics. The data substantiate many aspects of the theory of recapitulation and also provide circumstantial evidence for the long persistence of genetic elements (genes and gene parts) over many tens of millions of years alongside mutating genes that are naturally selected in the

phenotype by means of their changing effects upon genetic, developmental, and adult functions. There is likewise such detailed parallel evidence in both behavior and structure that we must assume the same basic biological and evolutionary principles underlying manifestations of behavior that we know to be foundational to the genetics, physiology, development, and function of structure.

ALFRED E. EMERSON
University of Chicago

Occurrence of Cladocera Remains in Lake Sediments

Many, possibly all, species of freshwater Cladocera leave recognizable skeletal remains in lake sediments. The family Chydoridae, with the greatest number and diversity of species, is best represented by a variety of skeletal parts. Present evidence indicates that the exuviae of these species accumulate in the sediments to form large populations, which can be studied by suitable statistical means for detecting changes in absolute and relative abundance during geological time.

To determine how accurately the population of fragments in the sediments reflects the living population that produced them, surface samples of the offshore sediments of the five lakes at Madison, Wis., in which E. A. Birge had studied the living Cladocera for more than two decades, were examined. Of the 23 species of chydorids found by Birge in these lakes, all except one (which he collected only on one occasion in one of the lakes) were recovered. In addition six other species were found that Birge had not encountered in his examination of living material.

Hence, any list of species of Cladocera based only on living material, even though collections were made at all seasons of the year and over a number of years, must be suspected of being incomplete. Obviously microhabitat requirements and seasonal and long-term vagaries of occurrence of the various species make it virtually impossible to collect all the species present. A list of species—at least of chydorids—occurring in a given body of water can be obtained with least expenditure of time and greatest assurance of completeness from an examination of the sediments.

DAVID G. FREY
Indiana University

Sputtering of Silver by Hydrogen Ions in the Energy Range 2 to 12 Kilovolts

Ion beams from a radio-frequency source were analyzed magnetically and allowed to strike a silver target incorporating radioactive Ag^{110} as a tracer. The sensitivity of the detection of sputtered silver was 10^{-8}g, so that the sputtering coefficient S (atoms of metal sputtered per incident ion) could be measured with minimal alteration of the surface of the target. Examination by electron diffraction revealed no contamination of bombarded targets by surface films. The ions H^+, H_2^+, H_3^+, D^+, D_2^+, and D_3^+ were studied at normal incidence from 2 to 12 kv. At 10 kv the values of S were 0.028, 0.070, 0.110, 0.075, 0.165, and 0.28, respectively. The variations of S with ionic energy displayed broad maxima in the region studied, which were displaced to higher energies with increasing mass of the ions. With hydrogen ions in this energy range, inelastic collisions due to electron excitation may account for an increasing proportion of the energy loss in the target and thus contribute to the decline in S at higher energies. Collision theory permits a rough calculation of S in this range, agreeing in order of magnitude with the observations. Although the present values of S are much lower than those reported by previous workers, who did not use analyzed beams, they are still so high as to suggest that sputtering from the walls of containers may cause serious difficulties in the achievement of nuclear fusion in deuterium plasmas.

FINN GRØNLUND, WALTER J. MOORE
Indiana University

Nuclear Syntheses and Induction of Mutation

About half way through the interdivision interval, there is a major discontinuity (D) in the frequency of recessive lethal and slow growth mutations induced by x-rays in the micronucleus of *Paramecium aurelia*. This is not true for mutation induction by 2537-A ultraviolet light. X-irradiation before D produces about 10 times as much mutation as x-irradiation after it. Moreover, certain postirradiation treatments decrease the amount of mutation if started before, but not after, D. The change in apparent sensitivity at D is very rapid, probably requiring only a few minutes for any individual paramecium. It has not yet been possible to follow the major macromolecular syntheses in the micronucleus, but its cross-sectional area starts to increase at or near D and continues to increase throughout the second half of the interdivision interval. Optical measurements of macronuclear DNA (Feulgen), RNA (2650-A absorption), and dry weight (interference microscopy), carried out in collaboration with T. O. Caspersson and his associates in Stockholm, have shown that all three start to increase at or near D and continue to increase throughout most of the second half of the interval. Quantitative autoradiographic determinations of the uptake of tritiated thymidine into the macronucleus follow the same pattern. Since irradiation at any time during the second half of the interval induces very little mutation, the general state of the replicating nucleus rather than the replicated or nonreplicated condition of individual chromosomes or DNA molecules must be responsible for preventing a large part of the radiation damage from being converted into mutation. The ineffectiveness of postirradiation treatment begun after D could mean that the mutational process comes to an end at this time; but it could also mean that the treatments are unable to modify the course of synthesis once it is under way. Thus it is possible to reconcile the idea that the end point in mutation induction is DNA synthesis with the association of D with the onset, instead of with the whole period, of DNA synthesis.

R. F. KIMBALL
Oak Ridge National Laboratory

Nucleon Structure from Electroproduction of Pions

By use of the methods of the dispersion relations, Fubini, Nambu and Wataghin [*Phys. Rev.* **111**, 329 (1958)] showed that experiments on the production of pions in electron-proton collisions may be used to study the electromagnetic structure of nucleons. A new attempt at the evaluation of these dispersion relations has been made by assuming only that the (3, 3) state of the final pion-nucleon system is dominant and that the one-meson approximation is applicable. Both assumptions are expected to be valid at pion-nucleon center-of-mass-energies in the neighborhood of the resonance, regardless (within reasonable bounds) of the magnitude of the momentum transferred by the electron. With this approximation, the dispersion relations may be interpreted as integral equations and solved by conventional methods. The reliability of these results with regard to measurements of nucleon structure may be partially ascertained by comparing a certain limiting form of these formulas with experiments on photomeson production. Work on this comparison is in progress.

SOLOMON GARTENHAUS
Purdue University

Problems in Genetic Control of Protein Synthesis

Recent advances permit the following formulation of the problems of the genetic control of protein synthesis. Each statement is suggested by existing evidence, but full validation lies in the future. (i) The outstanding biological property of proteins is specificity (enzymatic and immunological). Genetic alteration of purely physical properties (thermostability, electrophoretic mobility, and so forth) occurs, but constitutes a less critical problem. (ii) The important variables of the protein molecule are those of primary structure (amino acid sequence) and tertiary structure (folding, polymerization, and so forth). While the primary structure specifies an array of potential tertiary structures, the particular tertiary structure assumed in any case depends on other factors. (iii) The groupings responsible for specificity are large enough to extend over a segment of the polypeptide chain consisting of several adjacent amino acids or over two or more nonadjacent segments brought into juxtaposition by folding of

the chain. Alterations of either primary or tertiary structure could therefore affect specificity. (iv) Primary structure is a product of events occurring in the ribosome and is probably a reflection of the structure of ribosomal RNA. The sequence of nucleotides is probably the structural feature of greatest importance in this regard, but such features as folding of the polynucleotide chain cannot be dismissed. (v) Full specification of tertiary structure occurs subsequently. While nonspecific factors might play a role, it is difficult to avoid the participation of templates at this point; this may be an additional function of RNA. (vi) The problems of information transfer from genetic material to RNA templates are most profitably discussed in terms of nucleotide sequences in DNA, but the participation of either RNA or protein in the genetic code cannot be excluded. (vii) Information specifying both the primary and tertiary structures of proteins is coded in that part of the genetic material called euchromatin. The integrated units of this code need not be coextensive with the units of genetic recombination, and interactions between such units may occur either in the formation of RNA templates or at the level of template activity. (viii) Heterochromatin contains information restricted to the determination of aspects of tertiary structure not specified by amino acid sequence. Alterations in heterochromatin, therefore, are less likely to result in changes in the specificity of proteins and more likely to result in changes in purely physical properties.

ALLEN S. FOX
Michigan State University

Frequency-Modulated Ultrasonic Interferometer; Adiabatic Compressibility of Aqueous Solutions of Some Alkali Halides at 25°C

The determination of adiabatic compressibilities of aqueous solutions is part of our comprehensive study of the thermodynamic properties of strong electrolytes. The adiabatic compressibility β_S of a solution may be determined from measurements of its density d and the velocity u with which it transmits sound, using the equation of Newton and Laplace:

$$\beta_S = 1/u^2 d$$

Here $\beta_S = (\partial \ln V/\partial P)_S$, where V is the volume, P the pressure, and S the entropy.

The liquid is contained in a cylindrical cell, closed at the bottom by a transmission plate covering an x-cut quartz transducer and fitted with a movable reflector. The cell is connected in an RF bridge, the output of which changes with the reactance of the system as the reflector moves through a standing-wave position. Instead of using a fixed-frequency oscillator and presenting this change on a microammeter, we modulate the oscillator by about 5 kcy/sec and present the amplified bridge output on the upper channel of a two-channel oscilloscope as a horizontal trace with a sharp maximum at the standing-wave frequency. The reflector is then moved to bring this maximum to exactly 4 Mcy/sec, as indicated by a pip introduced on the lower (frequency) trace by a quartz crystal marker. This allows rapid and easy adjustment of the reflector position to 1 μ. The accuracy of the instrument now is limited by the uncertainty of ± 2 μ (standard deviation) in the micrometer reading.

Results for some alkali halide solutions will be presented.

FRANK T. GUCKER, CEDRIC L. CHERNICK, PHANIBHUSAN ROY-CHOWDHURY
Indiana University

Origin of Helianthus multiflorus

The cultivated ornamental sunflower, *Helianthus multiflorus* L., has been known since 1591 when it was described from Europe by Tabernaemontanus. The plants are sterile and are propagated by division of the rhizomes. Both Gray and Bailey have concluded that this taxon is a variety of *H. decapetalus*. Dod was the first to suggest a possibility of a hybrid origin with *H. annuus* and *H. decapetalus* as the parents. *Helianthus multiflorus* has been found to be triploid ($2n$=51). Morphologically, the plant is similar to *H. decapetalus* (n=34), but it differs from the latter in that it has a slightly more hispid stem, broader and more conspicuously serrated leaves, larger heads, and a more attenuated middle cusp of the chaff, all of which could have been derived from *H. annuus* (n=17). The artificial hybrid between these two species, while not readily obtained, has been secured, and the hybrid is similar in appearance to *H. multiflorus*. It is concluded, therefore, that *H. multiflorus* originated in Europe by spontaneous hybridization between *H. annuus* and *H. decapetalus*, after the introduction of these species from North America. *Helianthus annuus* was well known in Europe by 1591, but there is no mention of *H. decapetalus* before 1753, although it is quite probable that it was introduced at a much earlier date.

CHARLES B. HEISER, JR.
Indiana University
DALE M. SMITH
University of Kentucky

Some Consequences of Introducing a Genetically Defined Population of a European Syngen of Paramecium aurelia into an American Pond

Syngen 9 of *Paramecium aurelia* occurs in Europe but has never been found elsewhere. Approximately 4.6 million animals were introduced on 10 July 1959 into a small pond near Bloomington, Ind. They consisted of equal numbers of the three genotypes for two serotypic alleles and were approximately isogenic for other loci. Each genotype was equally represented by the two mating types. The pond also contains *P. caudatum* and *P. multimicronucleatum*, but no other *P. aurelia*. The introduced animals were regularly recovered in replicate 5-ml samples taken from 12 stations in the pond during the subsequent 3 months. The numbers of paramecia recovered have varied markedly, but no conspicuous difference among the three species in this respect has yet appeared. All marker genes and all genotypes put into the pond have regularly been recovered. The introduced proportions were markedly different from expectations on random mating. During the first month, the proportions recovered, though they fluctuated, did not differ significantly from the proportions introduced (except at one station). Later, significant deviations from the introduced proportions were found. The frequency of one allele has increased, the other has decreased. The proportions of the three genotypes deviate not only from the input ratios but also from the ratios expected to result from random mating. Fewer heterozygotes and more of both homozygous genotypes occur than is expected from random mating. Further samples are to be obtained periodically.

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HOWARD E. HOLZMAN
Indiana University

Host Range and Host Reactions as Diagnostic Criteria in Synchytrium

Synchytrium is a genus of obligate fungus parasites of plants which induce cell enlargement, division, and sometimes cell differentiation in their hosts. These reactions result in the formation of galls of varying complexity around the parasites. Inasmuch as the developmental and morphological characteristics are not sharply defined in most species of *Synchytrium*, systematists have used the type and structure of the induced galls as supplementary criteria in the identification and diagnosis of species. To determine the validity of such criteria, several species were tested as to host range, and the reaction of the hosts was studied. *Synchytrium macrosporum*, under greenhouse conditions, has infected 630 species of 460 genera in 138 families of temperate and tropical annuals, shrubs, and trees, ranging from the Taxaceae to the Compositae. On some hosts the induced galls are simple and unicellular and less than 200 μ in diameter, while on others they are composite, large, up to 800 μ or more in diameter, and consist of several hundreds of cells. Furthermore, on some organs of the same host they may be simple and unicellular, and on other organs large, composite and multicellular. Accordingly, host range and host reaction, in *S. macrosporum*, at least, are not specific and valid criteria for identification and diagnosis. Host reaction is specific for one host and then only for specific organs of that host.

JOHN S. KARLING
Purdue University

Hereditary Galactose Sensitivity

Galactose transported into the mammalian cells as well as into many microorganisms (yeast, *Escherichia coli*) is metabolically inert unless it is phosphorylated and incorporated into a nucleotide, uridinediphosphogalactose. These two steps are catalyzed by the enzymes "galactokinase" and "transferase," respectively. The enzyme that catalyzes the "racemization" of uridinediphosphogalactose to uridinediphosphoglucose is called "epimerase." Hereditary blocks of "galactopermease" or galactokinase render cells "galactose negative" (that is, unable to use galactose as a carbon source). Galactose-negative cells which arise from hereditary blocks in transferase or epimerase develop abnormalities in growth or in function after the addition of galactose as an accessory substrate. These types of abnormalities will be called "hereditary galactose sensitivity."

Hereditary galactosemia in man arises from a defect in "transferase." This defect has been demonstrated in several types of cells. Liver and lens epithelium of galactosemic infants degenerate if the subjects receive galactose in the diet. In galactose-negative strains of *E. coli*, two types have been identified as galactose sensitives. One type, defective solely in transferase, can be induced by galactose to become static. Another type is defective solely in epimerase. In this case, as found by Fukasawa and Nikaido, addition of galactose prompts the development of rapid lysis (in hypertonic medium the formation of protoplasts or spheroplasts ensues). Galactose-1-phosphate accumulates during bacteriostasis or bacteriolysis. The continued generation of this ester is probably responsible for the unbalanced growth. The biochemistry of these two types of unbalanced growth is under study.

H. M. KALCKAR, M. B. YARMOLINSKY, H. WIESMEYER
Johns Hopkins University

Anophthalmia (or Microphthalmia) in the Mexican Axolotl Apparently of Genetic Origin but Conditioned by Low Temperature

Several instances of partial or complete anophthalmia were recently discovered in otherwise normal larvae of two groups, one a natural spawning, the other consisting of a few offspring obtained by artificial insemination. The affected larvae of the first group numbered 12 of 39, those of the second group 3 out of 19. Two features of significance were common to both groups: (i) the parents were closely related and (ii) the eggs had been kept at a low temperature (14.5° to 16.5°C) until about the time of hatching.

The parents of group 1 were re-mated, and the eggs of the small spawning thus obtained were divided into two groups, one of which was left at room temperature (about 22°C), while the second was kept at a temperature of 14° to 15°C. All of the 13 survivors of the first group had normal eyes; in 4 of the 10 in the low-temperature group the eyes showed abnormalities.

Early development of the affected individuals proceeds in normal fashion. Optic vesicles are formed and the head attains a size equal to that in the normal siblings. Subsequently, the formation, growth, and differentiation of eye structures fail in varying degree. Animals lacking vision exhibit a marked general hyperpigmentation.

R. R. HUMPHREY
Indiana University

Demonstration of a Normal Serum Macroglobulin Coprecipitating with the Bovine Serum Albumin (BSA)-Chicken Anti-BSA Aggregate

One of the most interesting, yet most perplexing, properties of the chicken precipitin system is the phenomenon of high salt dependency. Wolfe and his associates established that the precipitation can take place best in a salt concentration about 10 times that of the mammalian antiserum (that is, 1.5*M* NaCl). The evidence presented suggests furthermore that the increase in precipitation can be accounted for by a salting-out phenomenon of the soluble antigen-antibody complexes. Since chickens are commonly used in immunoembryologic and tolerance studies and since the data obtained are often subjected to broad generalizations, we thought that an investigation should be carried out to test the hypothesis that there may also be a non-antibody serum protein coprecipitating with the antigen-antibody complexes. Pooled chicken anti-BSA sera were analyzed immunochemically by first solubilizing the thoroughly washed antigen-antibody aggregate with a known amount of BSA. Studies with an ultracentrifuge revealed that a $S_{20,w}$ 20-22 component always appeared in the aggregate when the precipitin reaction was carried out under optimum conditions. Its appearance can be prevented by removing the $S_{20,w}$ 15 or greater components before reacting the antisera with the antigen. This component can be identified by the double serum-agar-diffusion method as the second slowest diffusing serum antigen. It is present in nonimmunized adult chickens. Immunoelectrophoretic studies showed that it does not react with specific rabbit anti-chicken γ-globulin reagent. Finally, a combined paper electrophoresis-double serum-agar-diffusion method revealed that it behaves like a β-globulin. The significance of these findings will be discussed.

T. MAKINODAN, N. GENGOZIAN, R. E. CANNING
Oak Ridge National Laboratory

Selective Radiation Coatings

A thin coating of a suitable black semiconductor can be prepared on a bright metallic plate to give a surface which will absorb most of the sun's radiation between 0.3 to 2.5 μ but which will not emit over 20 percent of the radiation of a perfect radiator in the infrared region between 7 and 10 μ. These coatings, described by H. Tabor, are important for the heating of boilers and thermoelectric generators in solar devices and space vehicles. They give a greater efficiency in the conversion of solar radiation into heat and they help to produce higher temperatures.

The chemical stability at high temperatures in air and in vacuum is important.

Experiments are described with several different metals and selective coatings. The coatings may be prepared by chemical reactions, but the best results have been obtained by electroplating a thin coating of copper or cobalt (5×10^{-5} cm thick) on bright nickel, silver, or platinum (depending on the temperature needed) and then oxidizing the plated metal in air at around 400°C.

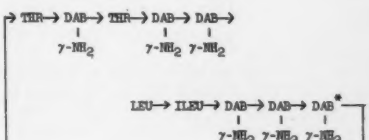
Experimental details will be given for methods of preparation and stability tests.

Hypotheses for the selective behavior will be discussed. The selectivity depends on the thinness of the coating, on its semiconducting nature, and on the character of the metallic oxide surface.

PANOS KOKOROPOULOS
FARRINGTON DANIELS
University of Wisconsin

Chemistry, Site of Action, and Biosynthesis of the Circulins

Bacillus circulans, strain Q19, synthesizes several lipopeptide antibiotics, the circulins; circulins A and B are the main products. Both are remarkably active against many Gram-negative bacteria and contain L-α, γ-diaminobutyric acid (DAB), L-threonine, D-leucine, L-isoleucine, and (+)-6-methyloctanoic acid (MOCT) in the molar relationship 6:2:1:1:1 [*Abstr. of Papers*, 133rd meeting, Am. Chem. Soc., 25C (1958); *Federation Proc.* **17**, 233 (1958)]. The structure of circulin A is as follows [*Abstr. Communs. 4th Intern. Congr. Biochem.* 9 (1958)]



Circulin B is identical to circulin A, with the exception that MOCT is attached through the γ-amino group of the DAB marked by an asterisk.

Because of the fact that the circulins possess a hydrophilic moeity (the cyclopeptide) and a hydrophobic portion (MOCT), we thought that these antibiotics might be cellular components having interfacial functions. However, recent work in collaboration with P. Knolle and H. R. Garner does not support this hypothesis.

On the other hand, they seem to act on bacterial surfaces, as is shown by the location of C^{14}-circulins within or near

the outer layers of the cell when these antibiotics exert their lethal action [*Bacteriol. Proc.* **1956**, 72 (1956)]. For maximum antibiotic activity the complete molecule is needed. The cyclopeptide, though only 2 to 2.5 percent as active as the parent compound, still possesses fairly impressive antibacterial activity. None of the constituent molecules, alone or in various combinations, is active.

T. Kobayashi and I recently succeeded in demonstrating the synthesis of circulins by sonically disintegrated cells of *B. circulans;* the activity resides mainly in the fraction that precipitates when the sonicate is centrifuged between 2000 and 15,000 grav for 30 minutes. The incubation mixture included L-DAB, L-Thr, L-Leu, L-ILeu, and MOCT (6:2:1:1:1), adenosinetriphosphate, and Mg^{++}, Mn^{++}, and K^{+} ions. Dialysis resulted in a decrease of the activity; addition of the dialyzate again increased the synthesizing capacity. D-Leu, the form of Leu found in the circulins, could not be substituted for the L-form. Further studies on the biosynthesis of these interesting compounds are underway.

HENRY KOFFLER
Purdue University

Energy Levels in Neon-22

The 21.8-Mev alpha particle beam from the Indiana University cyclotron has been used to excite the $F^{19}(\alpha,p)$ Ne^{22} reaction. The outgoing proton energies have been measured in double-focusing a magnetic spectrometer [Rasmussen, Miller, Sampson, *Phys. Rev.* **100**, 181 (1955)]. A large number of proton groups were seen and could be identified with the fluorine reaction. Groups were found corresponding to the ground state of Ne^{22} and known states at 1.28- and 3.37-Mev excitation energy. A state found at 4.52-Mev excitation energy was located at 4.9 Mev in earlier work [Ajzenberg-Selove and Lauritsen, *Nuclear Phys.* **11**, 1 (1959)]. Additional proton groups indicated previously unknown states in Ne^{22} at excitation energies of 5.18, 5.67, 6.41, 6.88, and 7.48 Mev. All of the energy measurements are $\pm$0.040 Mev.

H. J. MARTIN, M. B. SAMPSON
D. W. MILLER
Indiana University

Mutagenicity in Aspergillus terreus of Sublethal X-ray Doses and Its Modification by Chemical Protection

Saline suspensions of *Aspergillus terreus* spores show nonlogarithmic inactivation with 250-kv(peak) x-rays. The curves relating the logarithm of the surviving fraction to dose are S-shaped. Addition of cysteamine at concentrations above 0.1*M* extends the shoulder and reduces the slope of the inactivation curve (DRF = 1.8). It has previously been observed in many microorganisms that the percentage of mutations is inversely proportional to the percentage of spores that survive. Careful tests have shown that mutations are induced at low doses, when there is no killing, and that the number is proportional to the amount of energy absorbed. It is also shown that it is possible to reduce the number of mutations by irradiating in the presence of cysteamine without killing any cells. The linear relation between mutations induced and radiation dose is maintained whether or not any spores are killed. This finding indicates that the protection given by cysteamine against mutation induction is real and is not an artifact of slective survival or some other phenomenon that depends on killing of spores.

ALEXANDER HOLLAENDER
A. MARIE MCCARTHY
Oak Ridge National Laboratory

Disintegration of Lanthanum-131

The decay of La^{131} has been studied with the help of a magnetic lens spectrometer, scintillation spectrometers, and scintillation coincidence spectrometers. The half-life is 61 $\pm$ 2 min. Three positron groups have been found having end-point energies and relative abundances as follows: 1.939 $\pm$ 0.045 Mev (27 percent), 1.424 $\pm$ 0.036 Mev (56 percent), 0.704 $\pm$ 0.045 Mev (17 percent). Gamma rays are found at 115, 169, 214, 254, 285, 364, 417, 445, 511 (annihilation radiation), 597, and 878 kev. The line at 115 kev is strongly internally converted. A disintegration scheme is proposed.

This work was supported by the joint program of the Office of Naval Research and the U.S. Atomic Energy Commission.

ALLAN C. G. MITCHELL
CHARLES B. CREAGER, C. W. KOCHER
Indiana University

Far-Infrared Photoconductivity in Germanium

Elements of group III and group V, when introduced into germanium as impurities, have small ionization energies, of the order of 10^{-2} ev. At sufficiently low temperatures, the atoms of the impurities remain electrically neutral. Photoionization of the impurities adds conduction electrons or holes to the germanium crystal, giving photoconductivity which is expected to extend to the region of 100 μ. Photoconductivity in single germanium crystals containing arsenic or phosphorus has been investigated at liquid-helium temperatures, in the range 40 to 130 μ. The response showed a long wavelength, sloping edge in the region 80 to 100 μ for arsenic and 86 to 108 μ for phosphorus. These results are consistent with the absorption spectra measured in this laboratory, placing the ionization threshold near 88 μ for arsenic and 97 μ for phosphorus. At short wavelengths, the response per absorbed photon was nearly constant. The lifetime of the ionized charge carriers was estimated from the photoconductive response. Values of the order of 10^{-9} sec were obtained for both the arsenic and phosphorus-doped samples.

G. T. MCCONVILLE, H. Y. FAN
Purdue University

(d,p) Reactions in Bismuth and Uranium

A double-focusing magnetic spectrometer has been employed to observe the energy and angular distributions of proton groups from Bi^{209} targets bombarded by 11-Mev deuterons. The Q value of the most energetic proton group, previously unobserved, is found to be 2.34 $\pm$ 0.03 Mev. Since the ground-state Q value calculated from known binding and disintegration energies is 2.38 Mev, this group may represent either the ground-state or a low excited-state transition, or both. Broad but distinct proton groups were also observed corresponding to groups of states in Bi^{210} with mean excitation energies of 0.41, 0.88, 1.5, 2.02, 2.56, 2.81, 3.15, and 4.03 Mev. The observed properties of these groups yield interesting information on the neutron-proton interaction outside a closed-shell core of the atomic nucleus.

This work was supported by the joint program of the Office of Naval Research and the U.S. Atomic Energy Commission.

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Influence of Perfluoroalkyl Groups Adjacent to Reaction Centers

The purpose of this paper is to demonstrate the anomalous chemistry encountered with compounds carrying one or more perfluoroalkyl groups adjacent to a reaction center. The unique reactivities can be attributed to two most conspicuous features. One is the *inductive effect* exerted by the fluorine atoms, generally leading to a decrease in electron density at an adjacent reaction center of a given compound, thus influencing the chemical reactivity. The other factor to be aware of is *steric hindrance.* To illustrate the latter point, the effective diameter of the trifluoromethyl group lies approximately half way between the diameters of the trichloromethyl and the methyl groups.

In many instances both inductive and steric effects must be considered significant factors, and it is often difficult to decide the preponderance of one over the other.

Several results, evidencing this influence by perfluoroalkyl groups, are described in the field of aliphatic chemistry. Reactions have been carried out with halides, alcohols, ketones, aldehydes, acids, esters, and olefins, all carrying perfluoroalkyl groups adjacent to the reaction center.

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Nuclear Differentiation in Serotype Determination in Tetrahymena

A genetic analysis of serotype differences in two strains of *Tetrahymena pyriformis,* variety 1, reveals two types of segregation: a segregation of potentialities at meiosis, consistent with conventional

behavior of alleles at a single locus, and segregation of expressed serotypes during vegetative reproduction in all heterozygotes. The vegetative segregation can be interpreted as due to the fixation of the activity of one allele and the suppression of the alternate allele in each diploid subnucleus of the macronuclei, followed by a random assortment of differentiated subnuclei at each subsequent cell division. This system of mutual exclusion is superimposed upon a second, presumably of nonallelic specificities. Unlike the second system (Inoki and Matsushiro, 1958; Margolin *et al.*, 1959), the interallelic differentiations appear irreversible and incorporate no cytoplasmic component in their system of perpetuation.

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Threshold Discontinuities: Application to X-ray Scattering

It is shown that, in contrast to elastic and partial reaction cross-sections, the total cross-section averaged over the Coulomb resonances is continuous at the threshold of a channel of two outgoing oppositely charged particles. An instance in which the effects discussed should be experimentally observable is the elastic scattering of x-rays near a photoelectric threshold. It is shown that the discontinuity in that case should equal the size of the photo effect cross section.

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Use of Chromosomes Showing Meiotic Drive in Study of Population Structure

An individual heterozygous for alleles A and A' ordinarily produces progeny half of which carry one allele and half the other. Any deviation from this equality will have the immediate effect of altering the allele frequencies in a population. When such a deviation has its origin in an anomaly of the meiotic divisions, the phenomenon is referred to as meiotic drive. Chromosomes or alleles characterized by meiotic drive have, in principle, the capability not only of increasing their own frequencies but also of forcing into the genome of a species neutral or even somewhat deleterious genes inseparably associated with those chromosomes or alleles. Mutation, natural selection, or some other agent must counteract the disadvantage thus imposed on the species; otherwise its genetic make-up will be permanently altered. In this way, meiotic drive experimentally introduced into a population can be used as a tool to assess the relative efficacies of the agents of evolution, to define more accurately the structure of the population itself, or even to modify experimentally the genetic composition of a species. However, it is first necessary to derive artificially induced chromosomes or alleles showing meiotic drive before such an experiment can be considered seriously. This has been attempted in *Drosophila melanogaster*; two cases which appear to show drive, one involving the X-chromosome and the other the second chromosome, have been recovered from irradiated populations of *Drosophila*, suggesting that the phenomenon of meiotic drive may become a potent tool in the study of evolution.

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Remarkable Irregular Galaxy

The galaxies of irregular shape are not among the most frequently encountered in space, but they have especial interest because of the nature of their stellar population. The light of the majority of these systems is due principally to very large numbers of hot, blue stars; and the color of the light of the irregular galaxies is usually considerably bluer than sunlight.

Among the brighter members of the irregular class of galaxies there is one exceptional object, Messier 82, which is in marked contrast to the others. While the spectroscopic evidence indicates that most of its light comes from stars bluer (hotter) than the sun, the observed color suggests that the temperature of the radiation from Messier 82 is considerably lower than the solar temperature.

New observations carried out at the McDonald Observatory of the University of Texas in the spring of 1959 give the explanation of the discordance between stellar population and color. The behavior of the emission lines of hydrogen and oxygen indicates that Messier 82 is immersed in a great complex of dust; this dust reddens and dims the light from the stars comprising the galaxy.

The presence of the heavy dust absorption in Messier 82 sets off this irregular galaxy from most of the others of the same class; in general, the space between the stars in irregular galaxies seems to be transparent, and reddening and absorption effects are generally minor.

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Effects of a Protein Isolated from Mouse Salivary Gland, and Its Antiserum, on Mammalian Sympathetic Ganglia

Mouse sarcoma, snake venom, and mouse salivary gland contain closely related nerve-growth promoting agents which elicit exuberant nerve fiber outgrowth specifically from sensory and sympathetic ganglia of the chick embryo, both in vitro and in vivo. We have found that the mouse salivary gland agent has the same effect on sensory and sympathetic ganglia of mouse and human embryos in vitro. Fractions of the mouse salivary gland prepared by Stanley Cohen were injected daily into newborn, young, and adult mice, for periods ranging from 1 day to 1 month. In all instances, the sympathetic ganglia of the injected animals showed a remarkable increase in size. Maximal effects of a sixfold increase in volume were observed in newborn mice after 19 injections; the enlargement is due, in part, to an increase in cell number and, to a major extent, to cellular hypertrophy. The enlargement of the ganglia resulted in an overproduction of nerve fibers and hyperneurotization of the viscera. These results parallel previous findings in the chick embryo.

Stanley Cohen has found that an antiserum prepared against the purified mouse salivary gland agent, when injected into newborn mice, results in a near-total destruction of the sympathetic ganglia. We have found that this antiserum has the same destructive effects on the sympathetic ganglia of newborn rats, rabbits, and kittens. A similar but less severe effect was obtained in adult mice. The injected animals were otherwise as healthy and vigorous as controls.

RITA LEVI-MONTALCINI
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Separation of Growth-Promoting Activity of Serum for Tissue Culture Cells by Dialysis

The dialyzate from horse serum dialyzed against a relatively small volume of synthetic medium or salt solution has been found to be capable of substituting for whole serum in tissue-culture growth medium. The dialyzate in combination with synthetic medium 1066 supports the growth of six cell strains thus far tested (HEP 2, Giardi human heart, J-96, LLMC 1, Hela, Mox and numerous clone cultures derived from Mox). The active factor (or factors) is released from the serum as a function of time and temperature. When serum is dialyzed at 37°C, growth-promoting activity was initially observed at about 72 hours with maximum activity appearing at about 120 hours. In the cold (4°C), 14 days were required before activity was detected. If serum was allowed to stand at 37°C for 7 days or more preceding dialysis, the activity was detected within 24 hours after dialysis commenced. With this method a preparation has been obtained which does not react with protein precipitants such as sulfosalicylic acid or trichloroacetic acid and which can support the growth of cells to the same extent as when whole serum is used in the medium. Prolonged dialysis results in the accumulation of substances which are precipitated by sulfosalicylic acid but which do not appear to be associated with growth-promoting activity. Indeed, the appearance of this material in the dialyzate coincides with a decrease in the ability of the dialyzate to support growth. A preliminary chromatographic separation of the dialyzate yielded six fractions of which four manifested growth-promoting activity. Studies on the chemical nature of the active fractions are being initiated.

DON P. METZGAR, JR.
MERWIN MOSKOWITZ
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Shape of the Beta Spectrum of Europium-152

Previous measurements of the shape of the highest energy beta group in the decay of 13-year Eu^{152} have suggested that the spectrum has a "unique" shape [Bhattacherjee, Nainan, Raman, Sahai, *Nuovo Cimento* **7**, 501 (1958); Cork, Brice, Helmer, Sarason, *Phys. Rev.* **107**, 1621 (1957)] or an "allowed" shape [Alburger, Ofer, Goldhaber, *Phys. Rev.* **112**, 1998 (1958)]. Measurements made with a strong, relatively thin source in a high-resolution spectrometer permit a definitive interpretation of the spectrum shape in spite of the presence of interfering internal conversion lines. The shape is found to be neither "allowed" nor "unique." For energies above $W = 3.2\ m_oc^2$, the distribution is best fitted by a shape factor

$$(W_o-W)^2 + .79(W^2-1) + 5 \pm 2$$

with $W_o = 3.902\ m_oc^2$, corresponding to an end point of 1.483 $\pm$ .007 Mev. The shape is consistent with what one might expect for a once forbidden 3− to 2+ transition with an abnormally high comparative half life.

This work was supported by the Office of Naval Research.

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Further Evidence of the Relatively High Rate of Origination of "Invisible" Detrimental Mutations

To develop a criterion of relative fitness including both survival and reproductive effectiveness, *Drosophila* X-chromosomes, to serve as "experimental" and "control," respectively, were first made coisogenic except for a small terminal region differentiated as regards yellow. After experimentals (nonyellows) were subjected to the chosen influence, each experimental chromosome and its (randomly picked) control were multiplied rapidly. Of each such experimental and control pair about 12 parallel sublines were then established in capacious culture jars, by putting into each jar 600 males, equally divided among experimentals and controls, and 600 females having attached X-chromosomes. In every generation parents were discarded, and offspring, after abundant accumulation, were transferred en masse. Thus the males' X-chromosomes competed severely without interchanging parts. Yellow was meanwhile "covered" by Y-chromosomes containing nonyellow. Anomalous interchange, via triploidy or chromosome detachments, was prevented by sterility genes. After 12 to 24 generations of competition a subline's resultant ratio was ascertained by crossing its males en masse to recessive females having separate X-chromosomes, and then scoring "regular" daughters for yellow.

Disregarding fitness changes of <10 percent as insufficiently conclusive, 10 pairs of chromosomes having neither member experimental showed one yellow inferior, also one nonyellow; 14 pairs whose nonyellows had before competitive breeding accumulated spontaneous mutations (evidenced by 10 percent lethals) heterozygously in females for 53 generations showed four fitness decreases, all nonyellows; 43 pairs whose nonyellows had averaged 16,000 r exposure in oogonia (lethal yield, 8 percent) showed 12 inferior, all nonyellows. These results confirm earlier conclusions that "invisible detrimentals" arise at least 3 to 4 times as frequently as lethals.

This work was supported by U.S. Public Health Service grant RG5286(C1).

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Incorporation of C^{14}-Leucine into Protein by a Cell-free Preparation from Maize Endosperm

A cell-free system that incorporates C^{14}-leucine into protein has been prepared from developing maize endosperm. A particulate preparation is obtained by grinding corn kernels with sand in the cold and extracting with 1 volume of 0.45*M* sucrose. The homogenate is centrifuged at 1000*g* and 10,000*g*, and finally the particles are collected at 100,000*g*. These particles, when suspended in distilled water and incubated at 37°C in phosphate buffer at *p*H 7.0 with C^{14}-leucine, catalyze the incorporation of the amino acid into particle protein. The incorporation system requires ATP, GTP, Mg^{++}, and an ATP-generating system. The incorporation is markedly inhibited by 200 μg of chloramphenicol and by treatment of the particles with ribonuclease. When the particles are washed with distilled water they lose 90 to 100 percent of their ability to catalyze the incorporation. Full activity is restored by supplementation with a *p*H 5.2 preparation from the 100,000*g* supernatant or by a similar fraction prepared from rat liver supernatant. The incorporation efficiency of this system is comparable to that reported for the rat liver microsomal system—that is, 1 to 2 percent of the added radioactivity appears in the protein.

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Mutational Load Due to Detrimental Genes in Man

Morton, Crow, and Muller [*Proc. Natl. Acad. Sci. U.S.* **42**, 855 (1956)] estimated from studies of increased mortality in children of consanguineous marriages that the average person carries heterozygously the equivalent of 3 to 5 recessive lethals acting between late fetal and early adult stages, due to a mutation rate to such genes of 0.03 to 0.05 per gamete per generation. This theory of lethal equivalents has now been extended to detrimental traits, not measured as mortality, for which consanguinity may be ascertained either prospectively, before studying morbidity, or retrospectively, as a family study of ascertained cases (probands). In the latter case, if the incidence of the trait I and the mean inbreeding coefficient of probands $\bar{F}$ are known, the relation between the frequency of the trait P and the inbreeding coefficient $\bar{F}$ can be estimated as $P = 1 - e^{-(A+B\bar{F})}$, where $A = I - B\alpha$ and $B = I(\bar{F}-\alpha)/\sigma^2$, and α and σ^2 are the mean and variance of F in the general population.

This theory is applied to data on malformations, deaf mutism, limb-girdle muscular dystrophy, and mental defect, in which it is possible by appropriate methods to isolate the components due to simple recessive genes. Under this condition the theory simplifies greatly and leads to a distinction between mutational damage (the mutational load) and segregation from superior heterozygotes (the segregation load). The evidence indicates that most of the genetic load revealed by inbreeding is due to mutational damage. The mutation rate per gamete is $s[A + (A+B)\alpha']$, where s is the selection against the trait in question and α' is the long-term inbreeding coefficient. The number of loci or complementary alleles undergoing mutation is at least $(A+B)^2/A$, and the mutation rate is approximately 10^{-5} per locus per generation.

N. E. Morton
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Genetic Basis of Somatic Damage Produced by Radiation

The loss of individual chromosomes, caused by their breakage, forms the chief basis of the mortality induced by irradiating *Drosophila* larvae was indicated by results (Oster, 1959) showing that males are more often killed than females, and males with a ring X-chromosome, which restitutes with difficulty, more often than ordinary males. Moreover, Oster's finding that one ring X-chromosome hardly impairs the survival of females indicated chromosome loss, not chromosome bridge formation per se, as the usual cause of mortality. Tests both by Oster (1959) and by us showed further that, as expected for chromosome loss involving breakage, females having attached X-chromosomes considerably exceed ordinary females in mortality (though complications prevent their distinctly exceeding males).

We now find that females heterozygous for either of two known deficiencies in the X-chromosome have as high mortalities as males. Even the loss of a major autosome seldom kills unless its homologue is deficient. These results also bespeak chromosome loss, not bridge formation per se, or mere deletion of a chromosome section.

However, chromosomes which are pulled poleward with high effectiveness (for example, Novitski's "X.Y" and chromosomes of early zygotes) do kill by bridge formation. For mortality caused by irradiating such chromosomes is not conditional on their loss occasioning a deficiency.

Mortality caused by irradiating larvae

continues throughout life, thus resembling aging although probably different qualitatively from spontaneous aging. Although these mortality-dosage curves are sigmoid (multi-hit), chromosome losses are induced linearly at low dose-rates; hence "aging" accruing therefrom should depend on total dose accumulated.

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Chemically Induced Mating without Mating Type Difference in Paramecium caudatum

Since the discovery of mating types in *Paramecium aurelia* by Sonneborn (1937), it has become evident that mating type differentiation occurs also in other species of *Paramecium*, including *P. caudatum*; and that such conjugation between animals of different mating type is initiated by a typical agglutinative mating reaction (involving ciliary adhesion) and is followed by more intimate holdfast union. Unexpectedly, it has been found that chemical agents can regularly induce the occurrence of conjugation between animals that do not differ in mating type, and that this reaction involves direct holdfast union without a prior agglutinative mating reaction. Although irregularities in the relative positions of the conjugants may sometimes occur, processes characteristic of normal conjugation—degeneration of cilia on the oral side of the animals, micronuclear divisions, breakdown of the macronucleus, transfer of gamete nuclei from mate to mate, and the development of viable clones from exconjugants—have all been observed. Important for chemical induction of conjugation is a low concentration of Ca. Highly effective agents are K, Mg, and heparin; less effective are Rb, Cs, and acriflavine; Na and Li are slightly effective. Some organic agents—for example, acetamide, biuret, and urea—promote the conjugation-inducing effect of the inorganic agents. These chemical agents can also induce conjugation between animals of different syngens in such a manner that both mating types of one syngen conjugate with one mating type of another syngen.

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Theory of Repetitive Discharge of Specific Afferents Underlying Fast Spike Waves of Evoked Cortical Responses

The spikelike discharges seen at the onset and during evoked cortical responses produced by single shocks to a sensory input have been ascribed by Chang to discharges in groups of afferent fibers terminating in the sensory cortex, each group with a different conduction velocity, by Bishop to successive groups of interneurones in the cortex synaptically activated after a first afferent fiber group discharge, and by Bremer to a series of discharges in specific afferents as a result of different conduction velocities in their finer intracortical branches.

The first spikelike wave it is agreed by all workers on the basis of latency, is the sign of activity in terminating specific afferents and the correspondence in the origin of the first sensorily evoked spike with the first spikelike fast wave in the similarly appearing pattern produced by direct cortical excitation was shown previously by their occlusiveness (Ochs). Evidence is presented that the second fast wave is similar in origin to the first, and also that the successive fast waves may originate in the same neural element. When recording from animals directly stimulated at the cortex by means of chronic implanted electrodes, ten or more such spikelike discharges may sometimes be seen instead of the usual two or three. This would indicate that some labile mechanism determines the number of spikelike fast waves and leads to the theory that they are a repetitive or oscillatory discharge of the specific afferents at their termination in the cortex.

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What Is the Infective Agent in Breis of Killer Paramecia?

Breis of killer paramecia of stock 51 have two activities: they kill sensitive paramecia (Sonneborn, Jacobson, Dippell, 1946); they can, under certain conditions, infect sensitives of appropriate genotype, converting them into hereditary killers (Sonneborn, 1948; Tallan, 1959). Killing activity and a distinctive enlarged form of kappa (the B particle containing a characteristic body, the refractile or R body) can be completely sedimented at 3000*g* (Preer, Siegel, Stark, 1953). The supernatant (containing virtually no killing activity) is rich in infective activity, indicating that B particles are not essential for infectivity. Most of this infective activity can be sedimented by centrifuging the supernatant at 5000*g*. This sediment contains a smaller form of kappa (N particles) which lack R bodies. N particles are also present in the sediment obtained at 3000*g* (Preer, Siegel, Stark, 1953). This sediment (containing N and B particles) kills sensitives so that its infectivity cannot be tested. However, it is possible to destroy its killing activity without destroying its infective activity. This is done by centrifuging brei at 25,000*g*, exposing the sediment to the detergent Duponal for 30 minutes, washing, and recentrifuging the suspension at 3000*g*. The sediment so obtained lacks 95 percent of the killing activity of comparable sediment from untreated brei but is highly infective; it contains free R bodies, apparently liberated by the disruption of B particles. Conclusions: (i) infective activity is correlated with the presence of N particles; (ii) neither B particles nor R bodies are essential for infection; (iii) the possibility that B or R, or both, can also infect has not yet been excluded.

This work was supported by grants to T. M. Sonneborn from the Rockefeller Foundation, the American Cancer Society, and the Atomic Energy Commission.

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Evidence of the Lower Mutagenicity of Chronic than Intense Radiation in Drosophila Gonia

To ascertain whether the principle, discovered by the Russells (1958) in mouse oögonia, of the lower mutagenic effectiveness of chronic than acute gamma radiation holds also in *Drosophila;* adult inseminated female *Drosophila* were exposed to 4000 r radiation from a cobalt-60 source, one group being irradiated evenly over 2 weeks at 11 r/hr while actively reproducing and another group getting the same dose within 31 seconds. Both groups were shielded similarly. We are grateful to H. J. Curtis and Dale M. Steffensen for arranging these irradiations for us at the Brookhaven National Laboratory. After both groups had been allowed to reproduce for 10 days subsequent to irradiation, the females were placed, singly, in fresh cultures. Daughters (F_1) that developed in these cultures were tested individually for recessive lethals in their maternal X-chromosome. Omitting tests of flies whose mothers proved to have preexisting lethals, the tests of the chronic series gave 7 lethals, all from separate treated mothers, among 537 F_1 females tested, and the tests of the acute series gave 32 lethals, including 6 that arose in three clusters of two sister F_1 females each, among 932 F_1 females tested. The respective percentages with their errors (in which clustering is allowed for) are 1.3 ± 0.5 and 3.4 ± 0.65. The difference is statistically significant and in the direction expected if flies resemble mice in the respect in question. Less conclusive evidence indicates that the same principle holds in *Drosophila* spermatogonia, both for the production of ordinary lethals and of minute deficiencies.

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Cytogenetic Studies on Human Somatic Cells in vitro

Techniques have been developed for culture of somatic cells from any individual; growth of such cells for indefinite periods without karyotype distortion; accurate chromosome identification; and quantitative plating whereby every cell produces an isolated colony so that effects of various agents on growth can be accurately titrated and mutant clones can be isolated. Their application in human genetic diseases may elucidate the pathogenesis, identify chromosomes on which

specific genes are carried, and provide cells with genetic markers for in vitro studies. Thus ovarian dysgenesis in the human female was previously shown to result from a missing sex chromosome, producing an XO constitution. A similar, though not identical condition, familial primary amenorrhea, has now been found with a male chromosome constitution (XY). Pedigree data indicate a recessive gene defect, presumably on the X-chromosome, which prevents normal male character expression.

X-ray survival curves for normal, diploid human cells reveal the mean lethal dose for reproduction to be 50 r. Quantitative analysis of the chromosomal dynamics in such irradiated cells confirms the chromosomal nature of the primary damage. If irradiated cells are fixed shortly after irradiation, only chromatid and chromosome breaks and deletions are observed. With continued incubation, broken ends recombine, leaving recognizably aberrant recombinations as the only visible evidence of radiation injury. The mean dose required to introduce one chromosome break per cell under these conditions is about 25 r. Thus on the average, two such breaks can produce reproductive death of the cell.

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Scattering Length and Effective Range Theory for Coupled Two-Body Channels

The threshold properties of a two-body channel which is coupled to other channels are investigated. In particular, we examine the "new" channel when it is coupled to only one or two other open, two-body channels. We describe the system by specifying generalized potential: a diagonal interaction for each channel and coupling interactions between the channels. A number of relations are derived among the following quantities: the complex scattering length and effective range describing the new channel, the phase shifts in the old channels, some matrix elements of the interactions, and some integrals over wave functions. We then illustrate the usefulness of some of these relations by solving, exactly, the problem in which a two-channel system is described by two coupled Schroedinger equations with square well potentials. The scattering length and effective range are also examined by means of a complex potential for the situation in which there are many coupled channels.

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New Theoretical Foundation for the Concept of Ionic Character

This paper is concerned with the nature of the two-electron chemical bond. It is shown that it is possible to define mutually orthogonal "atomic" and "ionic" wave functions such that they have optimum properties associated with the intuitive concepts implied by their names. Then in an extremely good approximation which is well defined and independent of a particular choice of basis functions, the bond may be described as a linear combination of these two orthogonal functions. The binding arises almost completely from the ionic-atomic cross-term in the square of the wave function for the bond. Application to the heteropolar two-electron bond leads logically to the definition of a theoretical parameter which has many of the characteristics of electronegativity difference. The Wang, Weinbaum, and Rosen approximate wave functions for the H_2 molecule are analyzed by this method. They are strikingly similar, demonstrating the invariant characteristics of the new functions defined here.

HARRISON SHULL
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Synthesis of Isomaltose

A method for directly coupling two glucose units in the α-D linkage is needed and to this end the insertion of the nonparticipating nitrate group into the second position of the known 3,4,6-tri-*O*-acetyl-β-D-glucopyranosyl chloride appeared attractive. The nitration was effected at −20°C with acetyl nitrate and the crystalline product, tri-*O*-acetyl-2-*O*-nitryl-β-D-glucopyranosyl chloride (I), underwent solvolysis with methanol in the presence of silver carbonate, and methyl tetra-*O*-acetyl-α-D-glucopyranoside was isolated after reductive removal of the nitrate ester with hydrogen and Raney nickel and subsequent acetylation. (I) reacted with 1,2,3,4-tetra-*O*-acetyl-β-D-glucopyranose in alcohol-free chloroform and in the presence of silver carbonate to yield, after reductive cleavage of the nitrate group, acetylation and chromatographic separation by Magnesol-Celite extrusive chromatography, β-isomaltose octaacetate (9 percent) and β-gentiobiose octaacetate (5 percent). The reaction is under further study.

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Mathematical Analysis of the Mating Type Determining System in Paramecium aurelia, Syngen 7

In *Paramecium aurelia*, syngen 7, mating type XIII may be genotype mt^{XIII}/mt^{XIII}; $mt^{XIII,\ XIV}/mt^{XIII}$; or $mt^{XIII,\ XIV}/mt^{XIII,\ XIV}$, and type XIV may be either $mt^{XIII,\ XIV}/mt^{XIII}$, or $mt^{XIII,\ XIV}/mt^{XIII,\ XIV}$. Because sexually produced progeny of animals carrying mt^{XIII} usually become type XIV, if genetically competent, while animals homozygous for $mt^{XIII,\ XIV}$ usually do not change mating type in the next sexual generation, Taub (1959) postulated that most matings in populations containing both alleles would be between heterozygous XIV's and XIII's homozygous for mt^{XIII}, when the following parameters are low: (i) the fraction, A, of autogamy among all sexual processes, and (ii) C_6, the frequency with which XIII's of genotype $mt^{XIII,\ XIV}/mt^{XIII,\ XIV}$ give rise to XIV's in the next generation, and C_1, C_2, C_4, and C_5, the frequencies with which the remaining four genotype-phenotype combinations give rise to XIII's in the next generation.

In order to test this postulate, equations were derived which describe, on the basis of random mating, the frequencies of the five genotype-phenotype combinations in any generation in terms of their frequencies in the preceding generation and of the six parameters. The equations were fed into a computer, using various test values for the eleven variables. The data obtained reveal: (i) A stable equilibrium is approached at rates depending upon the initial eleven values, even (under certain conditions) when either allele is initially at very low frequency. (ii) In all equilibria examined the mating type ratio is 1:1. (iii) The prevalence of the homozygote by heterozygote mating (as in genotypic sex determination of higher organisms), as postulated, was confirmed for cases of low C values (the empirically verified situation) and A values less than about 0.7. (iv) With higher A values, most matings are between homozygotes for $mt^{XIII,\ XIV}$, the kind of system prevalent in *Paramecium aurelia*.

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Biological Contamination of the Moon

The probability of survival of a terrestrial microorganism, accidentally deposited on the moon by an impacting lunar probe, is computed. A population of the least radiosensitive dormant anaerobic microorganisms, if exposed to solar ultraviolet radiation, would be totally destroyed in hours. The resulting organic dissociation products would remain intact for much longer periods of time; 0.1 to 10 years if the lunar surface magnetic field strength is much less than 10^{-2} gauss, and 10^4 to 10^5 years if it exceeds 10^{-2} gauss. Organisms shielded from solar illumination, perhaps in congealed dust matrix interstices, would survive for 10^9 years or more.

The possible existence of indigenous lunar organic matter, with which the remnants of deposited microorganisms might be confused, is then discussed. The rate of synthesis of organic molecules by solar ultraviolet radiation in the primitive lunar atmosphere is estimated. The consequent lunar surface density of organic molecules is probably greater than 10 gm/cm^{-2}. As the lunar atmosphere was dissipated, heat and radiation produced organic molecules of great complexity from the deposited material. Such organic matter would now be situated beneath overlying layers of meteoritic and other surface debris. If Whipple's picture of a congealed semiporous dust matrix is a correct description of these upper layers, the likelihood of contamination of indigenous or-

ganic matter by terrestrial organic matter would appear to be fairly small. But such contamination, if it did occur, would destroy possibly unique sources of information on such problems as the origin of life and the early history of the solar system. It is recommended that all hard-landing lunar probes be decontaminated.

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Yerkes Observatory

Genetic Basis of Mating Type Determination in Paramecium bursaria

The discovery of a breeding system comprising four interfertile (but self-sterile) complementary mating types in *Paramecium bursaria* by Jennings in 1938 led him to carry out an extensive genetic analysis aimed at establishing the mechanism of mating type inheritance and determination. Jennings' data led him to suggest that the four mating types are controlled by genotypic differences, but he was unable to assign genic formulae to each of the types. The present research confirms the suggestion proposed by Jennings; the mating types are now known to be directly controlled by genes at two unlinked loci. A similar two-gene hypothesis was considered by Jennings in 1942 but discarded because it failed to account for all of his data. Crosses among the present strains and their sexual progeny reveal that cells of mating type A carry dominant alleles at both loci, A^-/B^-; homozygous recessives, *aa/bb*, are type C; mating types B and D are respectively aa/B^- and A^-/bb. The cytological events of conjugation and nuclear reorganization confirm the genetic interpretation and the two-locus hypothesis satisfactorily accounts for most of Jennings' results. Jennings' rare instances of mating type instability within a clone may indicate changes in the expression of macronuclear genes ("mutation") but probably do not involve alterations of micronuclear genes. A similar interpretation is proposed for the qualitatively unexpected types which appear rarely in certain of Jennings' crosses. Several observations of Jennings, confirmed here, suggest that alleles at the B-locus regularly come to expression before those at the A-locus; the temporal sequence is independent of dominance and recessivity and has not, so far, been altered by changes in background genes.

R. W. SIEGEL, L. LARISON
University of California, Los Angeles

Biochemical Studies on the Action of a Gene Controlling Meiosis in Maize

The recessive gene ameiotic (*am*), when homozygous, completely suppresses meiosis in maize in both the male and the female sporocytes. Meiosis is replaced by a type of mitotic division.

Studies of free amino acids and sugars by paper chromatography have revealed no differences between normal and ameiotic plants. However, paper chromatogram of water or alcohol extracts of various organs of ameiotic plants show the presence of a compound giving a yellow fluorescence in ultraviolet light, which is almost absent in the normal plants.

Analyses of root tips and of young ears at different stages of development with regard to nucleic acids, their precursors and histones, have given the following results: (i) In the ameiotic plants there is an accumulation of certain acid-soluble precursors which are probably not incorporated into nucleic acids as rapidly as in normal plants. No acid-soluble material accumulates in vegetative meristematic regions such as root tips, nor in the very early stages of ear development prior to megasporogenesis. (ii) Ameiotic plants and normal sibs do not differ in the quantity of DNA or total nucleic acids, but the amount of RNA relative to DNA is greater in the ameiotic plants than in the normal ones. Differences were also found in the (iii) apurinic DNA fraction obtained after hydrolysis with dilute hydrochloric acid and (iv) in the relative amount of histones compared with DNA.

It seems probable that a critical balance between the two nucleic acids and between DNA and histones is essential for the onset of meiosis and for its normal progress.

S. K. SINHA
Indiana University

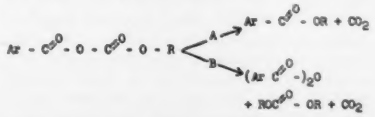
Hypoelastic Waves

Hypoelasticity is a smooth rate theory of large deformation. Although the differential equations of the theory are nonlinear, certain accelerationless disturbances may be propagated along surfaces of discontinuity. Such waves are determined and described in the present investigation.

C. A. TRUESDELL
Indiana University

Decomposition of Mixed Carboxylic-Carbonic Anhydrides

It was shown recently [Tarbell and Longosz, *J. Org. Chem.* **24**, 774 (1959); compare Windholz, *ibid.* **23**, 2044 (1958)] that the mixed carboxylic-carbonic anhydrides decompose by two paths, A and B.



The structural factors which determine the proportion of paths A and B were investigated, and it was found that with R an optically active group, there was complete retention of configuration of R during reactions A and B. A kinetic study of the reaction in solution by following the rate of carbon dioxide evolution now shows that the decomposition is powerfully catalyzed by amine hydrochlorides, dry HCl, sodium benzoate, lithium bromide, lithium chloride, and tetramethylammonium chloride, salts which are only slightly soluble in the reaction mixture. Lithium perchlorate is not a catalyst, although it is soluble. The reaction is much more rapid in dimethylformamide than in hydrocarbon or ether solvents, and the proportions of paths A and B are not affected by the presence of catalysts. A consideration of the rate evidence and of some additional stereochemical observations indicates that paths A and B have a common rate-determining stage and that the reactions occur by a set of ionic chain reactions.

D. STANLEY TARBELL, EDWARD J. LONGOSZ
University of Rochester

Rock-Stratigraphic Classification in the Pleistocene

The system of stratigraphic classification used in North America for all sedimentary rock units except nonmarine deposits of Pleistocene age establishes groups, formations, and smaller units on characteristics of the rocks and not on geologic time or geomorphic features. Students of the nonmarine Pleistocene have not kept these kinds of units distinct.

The Pleistocene sediments of Indiana and the surrounding states are of continental rather than marine origin, and thus they show far less lithologic homogeneity than sediments can and should be grouped into logical and usable formational units by lithologic characteristics. In such an approach, units that are wholly geomorphic such as terraces are omitted, but many time-lithic units now shown on most surficial geologic maps are not changed; rather, they are named as groups, formations, or members, or are regarded as facies. Four of the six formations proposed for Pleistocene sediments in Indiana have upper and lower contacts that correspond closely to time boundaries and are marked by key beds such as paleosols. The other two formations consist of several related lithofacies through which time boundaries may be drawn only with great difficulty, if at all.

Where this approach is used, local names can be designated for useful lithostratigraphic units in the Pleistocene series. Existing stage terminology is retained as time-stratigraphic nomenclature. This change in philosophy should be of particular value where problems of correlation with a standard time sequence frequently arise.

WILLIAM J. WAYNE
Indiana Geological Survey

Dynamics of Cell Ultrastructure in Development and Growth

In an actively growing root apex, cells may be followed through the stages of division, development, and growth directly along a short linear axis. An electron microscope study of the fine structure of cells in successive stages of development in the maize root has revealed an extensive general vesicular reticulum of which the nuclear envelope of the interphase cell is

a component. The system is such as to provide a relatively great lipoprotein surface area contact between the nucleus and the cytoplasm, between the nucleus and the surface of the cell, and, through intercellular connections, between the reticula of neighboring cells. This reticulum fragments during the prophase of mitosis, but the fragments remain in position around the dividing nucleus. If the cell is to divide again, the nuclear envelope is reconstituted as part of the general system. It is suggested that the Golgi apparatus, which appears to be very active at the time of cell division, may play a part in the formation of this extensive reticulum. Changes in the character of the system accompanying cell division and cell growth and the involvement of the reticulum in formation of the cell plate are discussed. Attention is directed to the implications of the findings for nuclear-cytoplasm-cell surface and cell-to-cell transport and to their possible importance in relation to cellular differentiation.

W. G. WHALEY

University of Texas

Beta-Gamma Directional Correlation Measurements in First Forbidden Transitions

The energy dependence of the anisotropy coefficient for the first forbidden beta decay and the subsequent gamma ray has been studied in the cases of Rb^{86} and La^{140}. The measurements were made with a small-shaped-field 180° beta-ray spectrometer which defined the electron energy and a movable scintillation gamma-ray detector. In the case of Rb^{86}, the anisotropy ranges from + 0.06 at 160 kev to + 0.19 at 630 kev. The values obtained at seven energies in this range are accurate to about 5 percent. It is hoped that with these more reliable data a theoretical analysis of the results may lead to a knowledge of the matrix elements involved in the decay. In the case of La^{140} the measured positive anisotropy of + 0.12 ± 0.03 at 1.67 Mev is to be compared with the theoretical value of + 0.133 which prevails for a spin sequence $4^- - 2^+ - 0$. This datum together with the results of Langer's shape determination of the high-energy beta group makes the spin assignment of 4^- to the ground state of La^{140} unambiguous.

R. G. WILKINSON
H. J. FISCHBECK

Indiana University

Theory of High-Energy Peaks in Pion-Nucleon Cross Sections

We wish to report an investigation of whether the spectrum of high-energy peaks observed at 650 Mev, 950 Mev, and 1.3 Bev in pion-proton scattering (and photoproduction) can be explained in terms of the conventional low-energy pseudoscalar pion-nucleon interaction. Previous investigation of this problem has yielded negative results, stimulating speculation on the role of pion-pion interactions. We suggest that the previous investigations of the pion-nucleon interaction have been inadequate. A Chew-Low formalism is outlined below which predicts two isobars, or metastable states, of the nucleon. We consider the two-*p*-wave pion, one static nucleon system, and explicitly examine the effects of the low-energy p 3/2 T = 3/2 pion-nucleon scattering resonance on this system. Loosely speaking, we consider one meson and then the next meson, and so forth, scattering in the 3/2 3/2 state, with respect to the nucleon. The propagation of the two-pion-one-nucleon system is being examined just as a mechanism for the existence of isobars. If the diagonal T matrix element in the two-pion-one-nucleon state is sharply peaked, the various observable cross sections, which we have not attempted to calculate, will also be peaked.

After making several approximations, we obtain an integral equation in which the basic parameter is the amplitude for finding one pion in the 3/2 3/2 state if the other pion is in that state. This amplitude depends on the total angular momentum and isotopic spin. A numerical solution of this equation leads to the definite indication of two isobars: the (even parity) states J,T = 5/2, 1/2 and J,T = 3/2, 3/2, which may correspond to the 950-Mev and 1.3-Bev peaks.

WEN NONG WONG, MARC ROSS

Indiana University

Regional Melanism in Aquatic Beetles

A significant number of the aquatic beetles (Coleoptera: Dytiscidae, Haliplidae, and Hydrophilidae) found in the flatwoods of Florida are much darker than their relatives in the adjacent coastal plain or in the Antilles. The Florida race of the *Tropisternus mexicanus* complex is a striking example. Most members of this rassenkreise are light-colored with narrow dark stripes on the elytra, but in peninsular Florida a very dark form (*viridis*) replaces the usual light race of the eastern United States (*striolatus*). Nonconcordance with environmental conditions, the steplike nature of the intermediates, and the absence of similar variants in other members of the genus indicate genetic rather than purely environmental control of the patterns. The occurrence of light-colored, *striolatus*-like, specimens in extreme southern Florida suggests that *viridis* may be a relatively recent mutant the genes of which have not yet spread through the entire Florida population. Dark forms such as *viridis* may be favored because they are less visible to predators in dark-bottomed habitats such as are common in Florida. If so, the regional melanism of the water beetles may be due directly to differential elimination of light and dark forms as in the "industrial melanism" of the moths of the English midlands.

FRANK N. YOUNG

Indiana University

Modification of Abnormal Genetic Ratios

Inequalities in recovery between members of each of two nonhomologous pairs of chromosomes and among the expected gametic types were reported by Novitski and I. Sandler (1957) from *Drosophila* males of "Stone's Bar" mutant type, possessing as one pair of homologues a fourth chromosome attached to a large distal piece of the X-chromosome and a normal fourth chromosome, and as another pair the proximal piece of the X-chromosome and the longer Y-chromosome. Despite the inequalities, simple cross-products of the recovered frequencies of the individual homologues gave expected gametic frequencies in excellent agreement with those observed. The authors suggested the possibility that not all the products of spermatogenesis are functional and that certain chromosomes, the longer ones, segregate preferentially into the nonfunctional meiotic products.

My experiments show that both pairs of homologues always vary in the same direction in any one experiment—that is, either members of both or of neither show inequalities in recovery rate. Moreover, otherwise indistinguishable Y-chromosomes and autosomes derived from different laboratory stocks appear to be responsible for the variation, for in the presence of NE ("no-effect") Y-autosome combinations, the inequalities tend to disappear while in the presence of E ("effect") Y-autosome combinations, inequalities are observed. The results suggest also that the greatest effect in the direction of either inequality or equality is observed when the Y-chromosome and all major autosomes are of the E or NE type, respectively, intermediate effects being observed in the presence of mixtures of E and NE chromosomes.

This work was supported by NSF grant G-5929.

S. ZIMMERING

Indiana University

Line Blending in Stellar Spectra

The absorption lines in stellar spectra provide the principal data for the determination of the abundance of the elements and the structure of stellar atmospheres. In some regions of the spectra of cool stars these absorption lines are crowded together and become blended. No satisfactory general method for disentangling the information present in a blend has thus far been devised and, consequently, blends are usually ignored in the quantitative analysis of stellar spectra. The availability of high-speed digital computers now makes it possible to study a great many theoretical models of line blending in detail. A program of this kind has been undertaken at the Indiana University astronomy department, making use of the IBM type 650 computer at our Research Computing Center. This paper is a report of the results of numerical studies of the simplest models.

MARSHAL H. WRUBEL

Indiana University

Growth of a Fireball

The potential commercial utilization of the heat of underground nuclear explosions has attracted a renewed interest in the detailed mechanics of the expansion of a nuclear fireball. The many phenomena which occur simultaneously in an actual nuclear explosion render difficult an over-all general picture of the explosion. The purpose of the present study was to obtain such an over-all picture by the method of introducing simplifying assumptions as to the medium in which the explosion takes place. The assumption that the explosion takes place in a hydrogen plasma enables us to obtain a complete analytical solution for the expansion of the fireball during that stage which precedes hydromechanical expansion. The most interesting feature of this analysis is the vertical drop of temperature at the boundary of the fireball.

C. ZENER
Westinghouse Research Laboratories

Symposium on Antibody Formation

William H. Taliaferro, *Chairman*

Effect of the Interval between Two Stimuli on the Height of the Secondary Antibody Response

Antibody formation takes place at a greatly accelerated rate in lymph nodes in cells of lymphoid tissue which have had a previous exposure to the antigenic stimulus. The increase in the rate of synthesis is dependent on a greatly increased number of cells which make a response in such an experienced cell population. For many years it has been known in an empirical way that good secondary responses were dependent on a delay between the application of the two stimuli. In order to answer the question whether there was transmittal of any kind of information by such experienced cells to their descendants, an experiment was carried out in mice testing the dependence of the peak secondary response on the duration of the interval between the first and secondary antigenic stimuli. It was found that the response increased in extent during the first 3 weeks after the first injection but that there was no further change, the subsequent response staying approximately equal throughout the whole of the interval examined (160 days). It is concluded that either there is no multiplication of the cells after the 3-week period or else that only one of a pair of daughters receives the information.

A. H. COONS, A. FECSIK
Harvard University

Cellular Phenotypes and Genotypes in Antibody Formation

An attempt has been made to devise a genetic approach to the immune response. To analyze the process in genetic terms, one must be able to study the phenotypes and genotypes of individual antibody-forming cells.

In a study of the phenotypes of antibody-forming cells, we have incubated cells from immunized lymph nodes singly in microdroplets. The antibody titration method used depended on the specific immobilization of motile *Salmonella* by small amounts of antiflagellar antibody. It has been shown that all antibody-producing cells belong to the plasma cell series and that far more cells form antibody in a secondary than in a primary response. Moreover, in a secondary response, individual plasma cells seem to form more antibody in a given time. When animals were immunized by a variety of schedules with two or three unrelated antigens, single cells formed detectable amounts of one antibody only. Nearly 2000 plasma cells from such animals have been examined, and in no case did one form detectable amounts of two or three antibodies.

The study of the genotypes of antibody-forming cells has been more indirect. Populations of immunologically competent cells have been transferred serially through immunologically neutral newborn rat hosts. While these experiments are at an early stage, the evidence is consistent with the view that cells are genotypically as well as phenotypically restricted in their antibody-forming capacity.

G. J. V. NOSSAL
Stanford University

Role of Antigen in Antibody Production

Three distinct cellular phenomena are involved in the process of antibody production. (i) In a small fraction of lymphoid cells there is a quickly reversible and visible change which lasts several days after an injection of antigen. During this time these cells synthesize large amounts of antibody—more than 100 molecules per cell per second. (ii) A specialization in the responsiveness of antibody-producing cells limits the response of a given cell to a few antigens. The degree of specialization of these cells is not known, but the number of cells responding to a given antigen increases after immunization with that antigen. The persistence of an animal's ability to make an anamnestic response indicates that specific responsiveness of a cell, once achieved, is lasting. (iii) Replication of antibody-producing cells is shown by a marked increase in mitotic figures in spleen and lymph node after an antigenic stimulus.

Two major questions concerning the mechanism of antibody production relate to the role of antigen and cell replication in the first two phenomena listed above. In the first case the question is whether antigen becomes an intrinsic part of the synthetic mechanism or acts only as a trigger. In the second case the question is whether the large numbers of specifically responsive cells in the immunized animal arise through an antigen-induced change or by selected replication of preexisting spontaneously differentiated cells.

DAVID W. TALMAGE
University of Colorado

Antibody Formation in the Primary and Secondary Response

Producing a primary response to ovalbumin (OA) and a simultaneous secondary response to bovine serum albumin (BSA) in rabbits injected with S^{35}-amino acids, we find almost identical specific activities in both precipitating antibodies. Evidently their bulk is formed from the same amino acid pool. In rabbits injected with S^{35}-amino acids before and with C^{14}-amino acids 3 days after the secondary dose of BSA or bovine γ-globulin in the ratio "S^{35} in antibody/S^{35} in γ-globulins" and the analogous C^{14}-ratio indicate the presence of some preformed antibody. Using the agglutination of antigen-coated erythrocytes as a test method, we find nonprecipitating antibodies over periods of at least 6 to 8 months after the primary injection of OA or BSA. We attribute the intensity of the secondary response to the combination of this circulating antibody with the reinjected antigen, rapid phagocytosis of the antigen-antibody complexes by reticuloendothelial cells, and subsequent formation of antibody in a large number of these cells; the antigen portion of the complexes may act as a template. In the primary reaction, where circulating antibody is absent and cannot act as carrier, only a few antigen molecules may reach the sites of antibody formation. Therefore the primary response is less vigorous than the anamnestic reaction. We see no need to invoke adaptation, selection or mutation as responsible for the intensity of the anamnestic reaction.

F. HAUROWITZ,
M. RICHTER, B. PATRAS
Indiana University

Antibody Formation by Single Cells

Antibody formation by single cells from the lymph nodes of hyperimmunized rabbits can be detected by distributing such cells in drops of very small volume (10^{-6} to 10^{-7} ml) containing culture medium. Using as immunizing antigens three serologically distinct bacteriophages, antibody specific for them can be assayed by inactivation in the drops of their plaque forming ability. Background controls are drops of culture fluid in which the cells are suspended during distribution in microdrops. A fourth bacteriophage is included in the drops as a volume control.

From such cells in mass suspensions and in microdrops the following facts have been ascertained: (i) As high as 20 percent of randomly chosen cells make γ-globulin specific for the immunizing bacteriophages. (ii) Cells do not make such γ-globulin in the absence of a course of immunization. (iii) A single cell can, and frequently does, make antibody to more than one bacteriophage. (iv) The ability to form antibody is not restricted to a single cell type, though cells of the plasmacytic series are the more frequent antibody formers.

EDWIN S. LENNOX
University of Illinois
MELVIN COHN
Stanford University School of Medicine

Association Affairs

Programs Planned for the AAAS Chicago Meeting

Section and society programs in anthropology, psychology, social and economic sciences, and history and philosophy of science to be presented at the Chicago meeting are given here. Programs in mathematics, physics, chemistry, astronomy, geology and geography, biological sciences, medical sciences, and agriculture have been previously announced [*Science* **130**, 1196, 1258, 1344 (1959)].

Anthropology

Section H. Vice-presidental address: "Archeology Today and Tomorrow," by John C. McGregor, University of Illinois; 28 Dec.; James L. Giddings, Brown University, presiding.

Symposium: "Biology and History in Archeology"; arranged by John C. McGregor; 28 Dec.; Donald Lathrap, University of Illinois, presiding. Papers on the historical knowledge gained through the analysis of molluscan shells once associated with the habitations of Indians (Max R. Matteson, University of Illinois); plant and culture movements in the Southwest (Hugh Cutler, Missouri Botanical Garden); the application of tree-ring dating to problems in archeology (Bryant Bannister, University of Arizona); the role of the zoologist in archeological interpretation (Charles A. Reed, University of Illinois); the relationship of archeology to history (J. Joe Bauxar, Rockford College).

There will be two sessions of contributed papers; 28 and 29 Dec.; Dwight B. Heath, Brown University, presiding.

Three-session symposium: "Technology as a Backstop to Anthropolgy and Archeology"; 29 and 30 Dec.; arranged by Ray Winfield Smith, Archaeological Institute of America, who will preside.

Part I. Papers on the role of trace-element geochemistry in archeology and anthropology (Karl K. Turekian, Yale University); microscopy in anthropology and archeology (Walter C. McCrone, Walter C. McCrone Associates, Chicago); study of ancient objects by means of neutron beams (Edwards V. Sayre, Brookhaven National Laboratory); technology from the point of view of the museum laboratory (William J. Young, Museum of Fine Arts, Boston).

Part II. Papers on metallurgy in the ancient world (William Campbell Root, Bowdoin College); chemical methods of trace analysis (Arnold M. Hartley, University of Illinois); x-ray spectroscopy as an analytical tool (L. S. Birks, U.S. Naval Research Laboratory); the application of thermoluminescence to problems in archeology (George C. Kennedy and Leon Knopoff, University of California).

Part III. Papers on techniques under development at the Research Laboratory for Archaeology and the History of Art (E. T. Hall, Oxford University); recent refinements in the C^{14} technique (Edwin A. Olson, Columbia University); electron microbeam probe studies of art objects (Norman Peterson and R. E. Ogilvie, Massachusetts Institute of Technology); expanding horizons of anthropology and archeology: the promise of technology (Ray Winfield Smith).

Psychology

Section I. Symposium: "Verbal Learning and Meaningfulness"; 29 Dec.; arranged by B. J. Underwood, Northwestern University, who will preside. Papers will be presented on a reevaluation of a scale of meaningfulness (E. J. Archer, University of Wisconsin); learning as a function of meaningfulness (B. J. Underwood); retention as a function of meaningfulness (L. J. Postman, University of California, Berkeley).

Vice-presidential address: "Some Neglected Possibilities of Communication." by Frank A. Geldard, University of Virginia; 29 Dec.; Clifford T. Morgan, University of Wisconsin, presiding.

Symposium: "Unconscious Processes"; 30 Dec.; arranged by C. W. Eriksen, University of Illinois, who will preside. Papers on discrimination without awareness (C. W. Eriksen); the problem of awareness (Don E. Dulany, University of Illinois); studies of dream deprivation (Charles Fisher, Mount Sinai Hospital); subliminal activation (G. S. Klein, New York University).

Symposium: "Brain Function and Learning"; 30 Dec.; arranged by W. D. Neff, University of Chicago, who will preside. Papers on somatic cortex and learned somesthetic discriminations (I. T. Diamond, Duke University); temporal cortex and learned auditory discriminations (J. M. Goldberg, University of Chicago); type of response as a central nervous system variable (R. A. McCleary, University of Michigan); the effects of mammillothalamic tractotomy on retention of conditioned avoidance responses and learned visual discrimination (G. J. Thomas, University of Illinois).

Section I is a cosponsor of the four-session symposium of the American Psychiatric Association; "Roots of Behavior: Animal Behavior"; 28 and 29 Dec.; reported in the previous issue of *Science* under Medical Sciences.

Social and Economic Sciences

Section K. Symposium: "World Population and International Relations"; jointly with the National Institute of Social and Behavioral Science, the American Economic Association, and the Population Association of America; 27 Dec.; arranged by Donald P. Ray, National Institute of Social and Behavioral Science, George Washington University, with William S. Vickrey, Columbia University and the American Economic Association, presiding. Papers will be presented on demographic factors in European diplomacy (Robert Strausz-Hupé, University of Pennsylvania); population and world economic development (Joseph J. Spengler, Duke University); vice-presidential address of Section K: demographic dimensions of world politics (Philip M. Hauser, University of Chicago).

There will be two sessions for contributed papers; 30 and 31 Dec.; Donald P. Ray, presiding.

American Political Science Association. Invited papers: "Scientific Knowledge and Public Policy-making"; cosponsored by AAAS Section K; 28 Dec.; arranged by James A. Robinson, Northwestern University, who will preside. Papers on designing systems for governmental decision-making in science (Richard L. Meier, Harvard University and Mental Health Research Institute, University of Michigan); scientists and public policy (H. Burr Steinbach, University of Chicago); science and international policy (Eugene Rabinowitch, University of Illinois, and editor, *Bulletin of Atomic Scientists*). Discussants: Marbury B. Ogle, Jr. (Purdue University), Duncan MacRae, Jr. (University of Chicago), and Harold D. Lasswell (Yale University).

American Society of Criminology. There will be four sessions of invited papers; 28 and 29 Dec.; arranged by Donal E. J. MacNamara, New York Institute of Criminology. Session I: "Psychiatry and Criminology"; Marcel

Frym, Hacker Psychiatric Foundation, chairman. Session II: "Problems in Police Administration"; Franklin M. Kreml, Northwestern University, chairman. Session III: "Research and Training in Criminology"; Peter Lejins, University of Maryland, chairman. Session IV: "Rehabilitation, Penology, and Criminology"; Vernon Fox, Florida State University, chairman.

Annual awards and memorial luncheon; 29 Dec.; Donal E. J. MacNamara, presiding. Award recipient: The Most Reverend Bernard J. Sheil, auxiliary bishop of Chicago, and chairman, Illinois Committee to Abolish Capital Punishment.

American Sociological Association. Symposium: "Use of Computers in Simulation of Social Behavior"; cosponsored by AAAS Section K; 28 Dec.; arranged by James S. Coleman, Johns Hopkins University, who will preside. Papers will be presented on a social influence process and its consequences (William McPhee, R. Smith, and S. Ferguson, Columbia University); direct factor analysis of sociometric data (Duncan MacRae, University of Chicago); dynamics of the behavior of a business firm (James G. March, Carnegie Institute of Technology); continuity of relationships among organizations imbedded in a communication network: assimilation study (Austin G. Hoggatt, University of California, Berkeley).

Symposium: "Trends in Family Formation and Structure"; cosponsored by AAAS Section K; 29 Dec.; arranged by Irene B. Taeuber, Princeton University, who will preside. Papers on plans for improving statistics of family formation and dissolution in the United States (Hugh Carter, National Office of Vital Statistics); social change and family structure: trends and prospects (Paul C. Glick, David M. Heer, and John C. Beresford, Bureau of the Census); discussant, Evelyn M. Kitagawa (University of Chicago); the tempo of reproduction in the family and in the population in Sweden (Norman B. Ryder, University of Wisconsin); discussant: Robert F. Winch (Northwestern University).

American Statistical Association. Symposium: "Descriptive Statistics"; cosponsored by Section K; 29 Dec.; arranged by Robert F. Winch, Northwestern University, who will preside. Papers on China's population statistics: the Ch'ing dynasty (Irene B. Taeuber); marital instability and its relation to education, income, and occupation: an analysis based on census data (Karen G. Hillman, Northwestern University); discussant, Robert M. Marsh, University of Michigan); seventy years of Illinois voting: 1888-1958 (Duncan MacRae, Jr., University of Chicago, and James A. Meldrum, Northern Illinois University); discussant, James A. Robinson (Northwestern University); estimation and use of production functions in agriculture (Earl O. Heady, State University of Iowa); discussant, Lester S. Kellogg (John Deere and Company).

Symposium: "Statistical Techniques"; cosponsored by AAAS Section K; 30 Dec.; arranged by Robert F. Winch, who will preside. Papers will be presented on "beyond factor analysis" (R. Darrell Bock, University of North Carolina); the use of forced choice questions and the power function (Robert McGinnis, University of Wisconsin); a reexamination of the repeated measurements problem (John W. Cotton, Northwestern University); a comprehensive model for reliability theory (Lee J. Cronbach, Nageswari Rajaratnam, and Goldine C. Gleser, University of Illinois); discussant, C. J. Burke (Indiana University).

Metric Association. Round-table discussion: "The Pharmacists' Method of Converting to Metrics"; 27 Dec.; discussion led by Harry E. Sagen, Abbott Laboratories. Papers on returns from the questionnaire of the British Metric Committee and the recent interest in metrics abroad (J. T. Johnson, Metric Association); the Metric Association's new membership campaign (Fred J. Helgren, Metric Association); why metric? an employee education program (L. A. Feiertag, Abbott Laboratories).

National Academy of Economics and Political Science. Invited papers: "The Underdeveloped Areas: Basic Problems of Growth and Development"; 30 Dec.; arranged by Amos E. Taylor, National Academy of Economics and Political Science, who will preside. Papers on sociological and demographic aspects of economic development (Philip M. Hauser, University of Chicago); some aspects of the economics of urbanization (Sidney C. Sufrin, Syracuse University).

History and Philosophy of Science

Section L. Two-session symposium: "Theory Construction in Logical and Historical Perspectives"; cosponsored by the American Philosophical Association and the Philosophy of Science Association; 27 and 28 Dec.; arranged by Herbert Feigl, University of Minnesota.

Part I; Herbert Feigl, presiding. Papers will be presented on the logic of discovery (Norwood Russell Hanson, Indiana University); discussant, Paul K. Feyerabend (University of Minnesota and University of California, Berkeley); the origins of relativity theory (Gerald Holton, Harvard University); discussant, Adolf Grunbaum (Lehigh University).

Part II; Adolf Grunbaum, presiding. Papers on the language of theories (Wilfrid Sellars, Yale University); discussant, Norwood Russell Hanson (Indiana University); the key property of physical laws: inaccuracy (Michael Scriven, Swarthmore College); discussant, Henry Mehlberg (University of Chicago); time's arrow and physical laws (Henry Mehlberg); discussant, Adolf Grunbaum.

Vice-presidential address: "Philosophical Tangents of Science," by Herbert Feigl; 28 Dec.; John W. Streeter, Franklin Institute, presiding.

Symposium: "Empirical and Conventional Elements in Physical Theory"; cosponsored by the American Philosophical Association and the Philosophy of Science Association; 29 Dec.; arranged by Herbert Feigl; Wilfrid Sellars, presiding. Papers on law and convention in physical theory (Adolf Grunbaum); discussant, Paul K. Feyerabend; meaning postulates in scientific theories (Grover Maxwell, University of Minnesota); discussant, Wilfrid Sellars; the empirical foundations of geometry (Ernest W. Adams, University of California, Berkeley); discussant, Norwood Russell Hanson.

Symposium: "Induction, Probability, and Simplicity"; cosponsored by the American Philosophical Association and the Philosophy of Science Association; 29 Dec.; arranged by Herbert Feigl; with Grover Maxwell, presiding. Papers on the probability of nonrecurring events (Nicholas Rescher, Lehigh University); discussant, William Rozeboom (St. Olaf College); induction, probability, and simplicity (Wesley Salmon, Brown University); discussant, Stephen Barker (University of Virginia); the role of simplicity in explanation (Stephen Barker); discussant, Wesley Salmon.

Symposium: "The Logic of Variables and Constants"; cosponsored by the American Philosophical Association and the Philosophy of Science Association; 29 Dec.; arranged by Herbert Feigl, who will preside. Papers on constant and nonconstant fluents (Karl Menger, Illinois Institute of Technology); discussant, Ernest W. Adams; problems of fundamental constants in physics (Wolfgang Yourgrau, Carleton College); discussant, Alfred Lande (Ohio State University).

Symposium: "Philosophical Issues of Quantum Theory"; cosponsored by the American Philosophical Association and the Philosophy of Science Association; 30 Dec.; arranged by Herbert Feigl; Henry Mehlberg, presiding. Papers on "from duality to unity in quantum mechanics" (Alfred Lande); discussant, Henry Mehlberg: some reflections on the interpretation of elementary quantum theory (Paul K. Feyerabend); discussant, Norwood Russell Hanson; are wave mechanics and matrix mechanics equivalent theories? (Norwood Russell

Hanson); discussant, Edward L. Hill, (University of Minnesota); quantum physics and relativity theory (Edward L. Hill); discussant, Paul K. Feyerabend.

Symposium: "Methodological Problems of Psychology and the Social Sciences"; cosponsored by the American Philosophical Association and the Philosophy of Science Association; 30 Dec.; arranged by Herbert Feigl; Wilfrid Sellars, presiding. Papers on methodological issues of the social sciences (Paul F. Lazarsfeld, Columbia University); discussant, Roger Buck (Oberlin College); the role of intervening variables in psychological theory (Herbert Hochberg, Northwestern University); discussant, Grover Maxwell; verbal utterances as data (Alex Buchwald, Indiana University); discussant, Roger Buck; formal analysis and the language of behavior theory (William Rozeboom); discussant, Alex Buchwald.

Philosophy of Science Association. Symposium: "The Theory of the Public Interest"; 28 Dec.; arranged by Wayne A. R. Leys, Roosevelt College. The discussants will be Lewis K. Zerby, Michigan State University, and Wayne A. R. Leys.

Society for General Systems Research. Business meeting and symposium: "The Synthesis of Organization"; 29 Dec.; arranged by Richard L. Meier, University of Michigan, with Anatol Rapoport, University of Michigan, presiding. Papers will be presented on self-organizing phenomena and the first life (Sidney W. Fox, Florida State University); the theory of plans and human behavior (Eugene Galanter, University of Pennsylvania); self-organizing systems (Heinz Von Foerster, University of Illinois).

There will be a session for contributed papers; 30 Dec.; Charles A. McClelland, San Francisco State College, chairman.

Society for the History of Technology. There will be two sessions of invited papers, cosponsored by AAAS Section L; 29 Dec.; arranged by Robert P. Multhauf, Smithsonian Institution. Session I; Carl W. Condit, Northwestern University, presiding. Papers on the social consequences of occupational specialization (Raymond Mack, Northwestern University); individualism and technological change (Homer Barnett, Oregon State College); commentator, Otis D. Duncan (University of Chicago). Session II; Robert Carlson, University of Pittsburgh, presiding. Papers on the Niagara power project (Harold Sharlin, Brooklyn Polytechnic Institute); medieval technology as reflected in the *Treatise on Divers Arts* of Theophilis (Cyril Stanley Smith, University of Chicago); the legend of Eli Whitney and interchangeable parts (Robert S. Woodbury, Massachusetts Institute of Technology).

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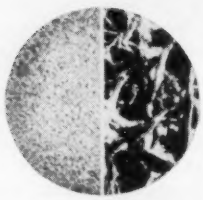

Left: Millipore Filter
Right: "Dense" analytical filter paper
(Photomicrograph at 100X)

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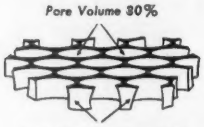

Solid (Matrix) Volume 20%

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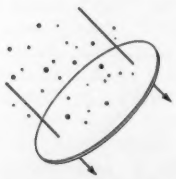

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VM	50 mμ	±3 mμ	2.7	200
VC	100 mμ	±8 mμ	3.6	600
PH	0.30μ	±.02μ	40	4200
HA	0.45μ	±.02μ	80	9600
DA	0.65μ	±.03μ	175	28000
AA	0.80μ	±.05μ	220	33000
RA	1.2μ	±.3μ	300	38000
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*Mean Flow rates in cc/min/cm² filter area @ 25°C and 70 cm Hg △ p

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Forthcoming Events

December

16–18. American Soc. of Agricultural Engineers, Chicago, Ill. (J. L. Butt, P.O. Box 229, St. Joseph, Mich.)

25–27. Indian Mathematical Soc., 25th conf., Allahabad, India. (B. N. Prasad, Allahabad Univ., Lakshmi Niwas, George Town, Allahabad 2.)

26–30. American Assoc. for the Advancement of Science, annual, Chicago, Ill. (R. L. Taylor, AAAS, 1515 Massachusetts Ave., NW, Washington 5.)

27–30. American Anthropological Assoc., Mexico City. (W. S. Godfrey, Jr., Logan Museum, Beloit College, Beloit, Wisc.)

27–30. American Astronomical Soc., Cleveland, Ohio. (J. A. Hynek, Smithsonian Astrophysical Observatory, 60 Garden St., Cambridge 38, Mass.)

27–30. American Folklore Soc., Mexico City. (MacE. Leach, 110 Bennett Hall, Univ. of Pennsylvania, Philadelphia 4.)

27–30. American Statistical Assoc., Washington, D.C. (D. C. Riley, 1757 K St., NW, Washington 6.)

27–30. Institute of Mathematical Statistics (weather control), Washington, D.C. (J. Neyman, Statistical Lab., Univ. of California, Berkeley 4.)

28–29. American Chemical Soc. (Div. of Industrial and Engineering Chemistry),

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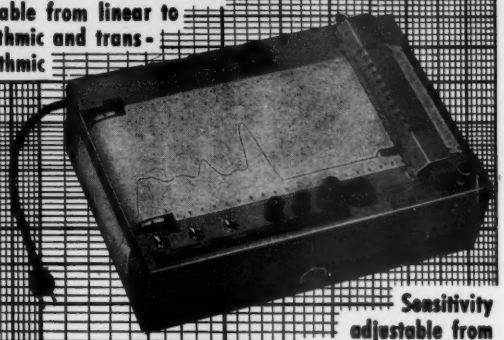

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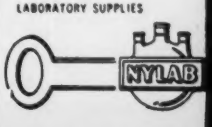

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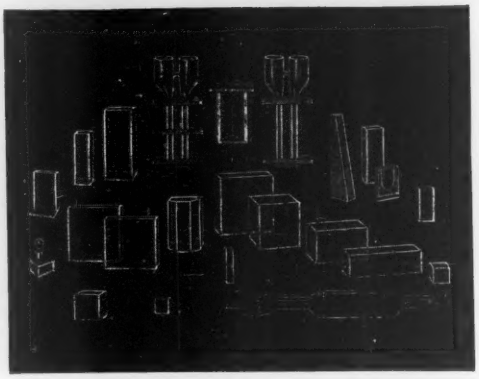

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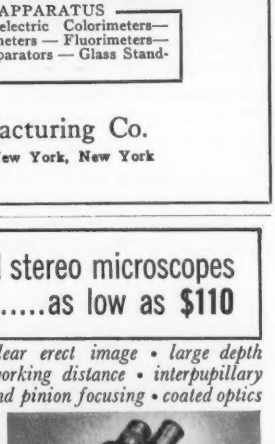

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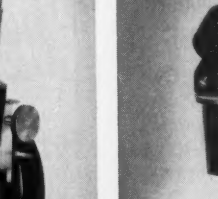

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symp., Baltimore, Md. (M. A. H. Emery, ACS, 18 and K Sts., NW, Washington D.C.)

28–29. Industrial Relations Research Assoc., Washington, D.C. (E. Young, Sterling Hall, Univ. of Wisconsin, Madison.

28–29 Mechanism of Interfacial Reaction, American Chemical Soc., annual symp, Baltimore, Md. (H. E. Hoelscher, Chemical Engineering Dept., Johns Hopkins Univ., Baltimore, Md.)

28–29. Lepidopterists' Soc., 10th annual, Ann Arbor, Mich. (E. G. Voss or W. H. Wagner, Dept. of Botany, Univ. of Michigan, Ann Arbor.)

28–29. Northwest Scientific Assoc., Spokane, Wash. (W. B. Merriam, Dept. of Geography, State College of Washington, Pullman.)

28–30. American Economic Assoc., Washington, D.C. (J. W. Bell, Northwestern Univ., 629 Noyes St., Evanston, Ill.)

28–30. American Philosophical Assoc. (eastern div.), New York, N.Y. (L. Garvin, Dept. of Philosophy, Univ of Maryland, College Park.)

28–30. American Physical Soc., Pasadena, Calif. (K. Darrow, APS, Columbia Univ., 116 St. and Broadway, New York, N.Y.)

28–30. Econometric Soc., Washington, D.C. (R. Ruggles, Dept. of Economics, Yale Univ., New Haven, Conn.)

28–30. Western Soc. of Naturalists, Los Angeles, Calif. (Y. U. Amrein, Dept. of Zoology, Pomona College, Claremont, Calif.)

28–31. Phi Delta Kappa, Columbia, Mo. (A. G. Clark, 316 Dalzell Ave., Ben Avon, Pittsburgh 2, Pa.)

28–16. Bahamas Surgical Conf., Nassau. (B. L. Frank, P.O. Box 4037, Fort Lauderdale, Fla.)

January

1–5. Electrochemical Soc., Chicago, Ill. (Electrochemical Soc., Inc., 216 W. 102 St., New York 25.)

1–5. Institute of Geographers, annual conf., Southampton, England. (A. E. Smailes, Queen Mary College, Univ. of London, Mile End Rd., London, E.1.)

3–9. Indian Science Cong. Assoc., 4th, Bombay. (B. W. Prasad, ISCA, Lakshmi Niwas, Georgetown, Allahabad 2, India.)

5–7. Recent Mechanical Engineering Developments in Automatic Control, symp., London, England. (Institution of Mechanical Engineers, 1 Birdcage Walk, London, S.W.1.)

6–8. Northeastern Weed Control Conf., 14th annual, New York, N.Y. (M. G. Wiltse, Chairman, Public Relations Committee, Dow Chemical Co., 916 Shoreham Bldg., 15 and H Sts., NW, Washington 5.)

7–10. Radioactive Isotopes, 4th intern. symp., Bad Gastein, Austria. (R. Hofer, Isotopen-Laboratorium, II. Medizinische Universitäts Klinik, 13, Garnisongasse, Vienna 9, Austria.)

8–11. Sanitary Engineering Conf., ASCE, Cincinnati, Ohio. (E. S. Kirkpatrick, ASCE, 33 W. 39 St., New York 18.)

11–13. American Acad. of Allergy, Hollywood-by-the-Sea, Fla. (J. O. Kelley, 756 N. Milwaukee St., Milwaukee 2, Wisc.)

(See issue of 13 November for comprehensive list)

New Products

The information reported here is obtained from manufacturers and from other sources considered to be reliable. Neither Science *nor the writer assumes responsibility for the accuracy of the information. All inquiries concerning items listed should be addressed to the manufacturer. Include the department number in your inquiry.*

■ SLIDE RULE, for teaching, is 8 feet long and is mounted on trundles that permit complete 360-deg turning without lifting. Scale arrangement and slide movement are the same as those of the manufacturer's standard 10-in. Log Log Duplex Decitrig slide rule. (Keuffel & Esser, Dept. Sci210, Adams and Third Sts., Hoboken, N.J.)

■ LABORATORY HYDRAULIC PRESS of 50-ton capacity has electrically heated platens measuring 12 by 15 in. Temperature of either platen can be read independently, measured by thermocouples and pyrometer. Controls are located at eye level. (Wabash Metal Products Co., Dept. Sci223, 1576 Morris St., Wabash, Ind.)

■ PULSE GENERATOR produces current pulses with output rise time variable to 35 mμsec and peak amplitudes 50 ma to 2.5 amp. Variable width, amplitude, and rise times are produced from external triggers at rates to 3 Mcy/sec. The device may also be operated as an amplifier with output widths controlled by input signal durations. (Electro-Pulse Inc., Dept. Sci224, 11861 Teale St., Culver City, Calif.)

■ CONTROLLED-TEMPERATURE BATH for 12 standard cells maintains 35°C within $\pm 0.01°$ corresponding to cell-output variation of 0.5 μv. Connection of positive sides of cells to individual binding posts permits each cell to be checked by changing one external connection. All wire and binding posts are made of copper to avoid thermal voltages. Approximately 4 gal of oil are required. (Daystrom, Inc., Dept. Sci226, 614 Frelinghuysen Ave., Newark 12, N.J.)

■ HIGH-VOLTAGE PROBE for oscilloscope is rated at 12 kv d-c or r.m.s., 25 kv peak. Attenuation ratio is 1000/1. Rise time is 12 mμsec and frequency response is d-c to 30 Mcy/sec. Input impedance is 2.5 pf paralleled by 100 megohm. A compensating network permits adjustment to oscilloscope input capacitances from 20 to 47 pf. (Tektronix, Inc., Dept. Sci227, P.O. Box 831, Portland 7, Ore.)

■ MICROWAVE STABILITY TESTER measures long-term drift and short-term deviation from 1100 to 10,000 Mcy/sec. Short-term accuracy is said to be $1/10^9$ and long-term accuracy $1/10^6$. Short-

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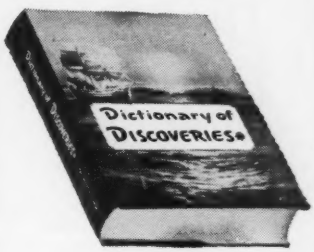
by I. A. Langnas



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■ OSMOMETER determines the vapor-pressure lowering of dissolved solutes by comparison of rates of evaporation of unknown and reference solutions. Small drops of solutions are placed in small loops formed by thermocouples. The assembly is placed in a chamber humidified by an aliquot of the reference material, and temperature difference is observed when steady state has been reached (about 15 min). (Rosemount Engineering Co., Dept. Sci229, Minneapolis, Minn.)

■ AUDIO RESPONSE PLOTTER provides a continuous single-sweep 20- to 20,000-cy/sec test signal and records test-system output on a 40 db-range logarithmic chart of a pen recorder. The oscillator is directly connected to the recording drum. Sensitivity is sufficient to record signals 40 db down from 10 mv. (Southwestern Industrial Electronics, Inc., Dept. Sci232, 10201 Westheimer Rd., Houston 19, Tex.)

■ HARDNESS TESTER is adapted to measurement of radioactive metals by mechanical linkages that extend control functions through the wall of a test cell. Seals on each coupler permit the cell to be isolated from outside atmosphere. Both Knoop and 136-deg diamond pyramid indenters are used with a dual system of weights from 1-to-3000 and 1-to-10,000 gm. Images from the viewing microscope are brought to an eyepiece outside the test cell. A mechanical stage carrying a turntable vise provides accurate traverses in two directions. Vise jaws can accommodate specimens up to 1¼ in. in diameter. The latter must be placed in the vise by mechanical hands or other accessory systems. (American Chair and Cable Co., Dept. Sci236, 929 Connecticut Ave., Bridgeport 2, Conn.)

■ CLEANLINESS TESTER assigns numerical values to surface cleanliness where nonbonded soils are involved. Soil is removed from the surface under test by pressure-sensitive tape and the latter is fixed to a microscope slide. Optical density of the composite is measured by the tester which is a densitometer specifically designed for that purpose. Reading is provided by a linear 0-to-1000 scale with accuracy said to be $1/10^3$. Branson Ultrasonic Corp., Dept. Sci237, 40 Brown House Rd., Stamford, Conn.)

JOSHUA STERN

National Bureau of Standards, Washington, D.C.

Letters

Support of Science by College Student Body

Associated student bodies of American colleges and universities have yearly budgets for student activities which may include hundreds of thousands of dollars. Monies generally come from the sale of student-body tickets, from admissions, and from publications. Expenditures include the support of athletics, music and arts, publications, publicity, administrative salaries, and general activities. In so far as is known by us, no student body has budgeted funds for the support of scientific research.

The Associated Student Body of Long Beach State College established a research board composed of students and faculty to further basic research on the campus. The purposes are (i) to provide increased opportunity for students to engage in scientific research; (ii) to increase scientific knowledge; (iii) to provide an activity which is a source of interest, pride, and prestige for the student body as a whole, and for the college; and (iv) to emphasize the need for acquainting the public with the goals and values of basic research.

The primary function of the research board, consisting of four students and three faculty members from the various areas of science, is to approve deserving research proposals submitted by student-faculty teams. Funds may be used for equipment, supplies, or salaries. Projects will be supported for a 1-year period; however, additional funds may be requested.

While the amount budgeted the first year is small ($1000, representing about 0.6 percent of the total student-body budget), it demonstrates that the undergraduate student realizes the value and the importance of supporting basic research.

DONALD J. REISH
RICHARD B. LOOMIS

Department of Biological Sciences, Long Beach State College, Long Beach, California

High-Altitude Observation

I have recently read with great interest the article by R. C. Staley "High-altitude observation techniques" [*Science* **130**, 845 (2 Oct. 1959)]. I would like to make the following comments relative to some recent developments.

1) The altitude limit of the rocket-grenade experiment for temperature

and winds has been pushed upward to 94 km. No appreciable further extension is in sight. [See W. G. Stroud, W. R. Bandeen, W. Nordberg, F. L. Bartman, J. Otterman, P. Titus, "Temperatures and winds in the arctic as obtained by the grenade experiment," *IGY Rocket Rept. Ser. No. 1, Natl. Acad. Sci. U.S. Publ.* (1958), pp. 58–79.]

2) The falling-sphere technique for determining upper-atmosphere density, which uses the transit-time accelerometer invented by L. M. Jones, has yielded atmospheric density data in series of experiments during the last few years. [L. M. Jones, F. F. Fischbach, J. W. Peterson, "Seasonal and latitude variations in upper-air density," *IGY Rocket Rept. Ser. No. 1, Natl. Acad. Sci. U.S. Publ.* (1958), pp. 47–57.]

3) In 1958 I proposed to the Air Force Cambridge Research Center an experiment involving a falling sphere with a stable platform and *XYZ* accelerometers. The experiment is now under study at the University of Michigan Willow Run Laboratories, under contract AF19(604)-5205. It appears that good density determination can be expected at altitudes up to 150 km and horizontal wind determination, at altitudes up to 120 km. Vertical winds can be estimated.

JOSEPH OTTERMAN
Willow Run Laboratories,
University of Michigan, Ann Arbor

I would like to express my appreciation to Joseph Otterman for his interest in my article and for his amendments to it. It is regrettable that these recent references, although available to me, escaped my attention. The purpose of my article was to call attention to material scattered through the literature. I hope other workers in atmospheric physics will share their discoveries through the pages of *Science* as well as through their own specialized periodicals.

RAYMOND C. STALEY
Department of Meteorology and Climatology,
University of Washington, Seattle

On Selecting "Immortals"

As a teacher of the history of science, I should like to be instructed by some of your readers. In a recent issue of *Science* [**130**, 150 (17 July 1959)], a news item lists the 25 "Immortals of Science" whose names will be carved in the walls of the new science building at the University of Bridgeport. I am not interested in the game of fighting for favorite names, but I should like to ask whether anyone can explain how the electors managed to include the name of Leonardo da Vinci—to be judged a genius, yes, but hardly a scientist, especially on the basis of the criteria set up by the university. In spite of the airplanes and studies of fluid flow, Leonardo did not (i) make "a fundamental discovery regarding the laws of nature," nor was he (ii) "responsible for an invention not based on a previously known fundamental law of nature."

Is this an example of the blind following of tradition? In case there are those who require annotations, let me refer them to the works of Leonardo himself, and to comments by Randall, Duhem, and Sarton.

I. WEBB SURRATT
Institute of Technology, Air University, Wright-Patterson Air Force Base, Ohio

Tax Deduction

In a recent issue [*Science* **130**, 86 (1959)], in discussion of a congressional bill to stimulate private philanthropy, mention is made of an 80-cent dollar for a person with a taxable income of $5000. This is only the case, though, if the itemized income-tax form is used. For those of us who take a straight 10-percent deduction, a dollar given away consists of 100 cents, with no tax rebate of 20 cents or even 9 cents.

WILLIAM I. MARTIN
Pittsburgh, Pennsylvania

Science Writing

The editors of *Science* and J. Allen Hynek are to be congratulated for the report "Occultation of the Bright Star Regulus by Venus" [*Science* **130**, 707 (18 Sept. 1959)]. To paraphrase Hynek's dramatic opening paragraph: In this age it is no longer often that we are given the opportunity to read so beautifully written and so personalized an account of a scientific observation.

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Department of Pharmacology,
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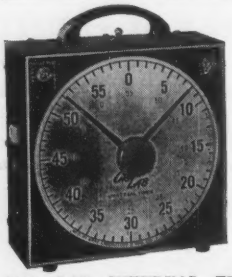

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